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THE HYDRAULIC FEATURES OF NIAGARA POWER.

The utilization of the greatest water power in the world has always possessed a fascination for engineers, due largely, perhaps, to the peculiarity so dear to the American heart that it is the greatest thing of its kind. A summary of the various plans for the hydraulic equipment may be of interest. The best location in some respects for a power plant would be at the head of the falls, where neither an extended head-race nor tail-race would be necessary, but the governmental reservations for æsthetic purposes preclude the construction of the power plants at such points.

The company earliest in the field with a complete system was the Niagara Falls Hydraulic Power & Manufacturing Company, a description of whose plant may be found on other pages of this issue. The plan originally and still followed in this company's work is the use of an open canal from still water above the rapids to the face of the cliff overlooking the gorge below, with penstocks down the side of the cliff to turbines near the tail-water level. At the time when a large part of this company's work was carried out wheels could not be made for the high head obtainable, and but a small part of the total available head was utilized, the water discharging from orifices in the face of the wall and forming miniature cataracts to the gorge below. Later equipments, however, utilized practically the whole head, the loss in the canal and penstocks being only three or four feet of the total 216.

The comparatively small plant on the Canadian side (also described in this issue) is exceptionally favorably situated for short hydraulic passages. Its tail-race tunnel is but 700 feet long, and its head-ditch is even shorter. It utilizes, however, but a small part of the available head, and that on only a small scale and in a primitive manner.

When the Niagara Falls Power Company took up the question of a further development ten years ago it was found impractical to use a surface canal with a power plant on the river's edge below, owing to the government reservation, the cost of real estate which it would have been necessary to use and the rights of the other company to the water front in the gorge. The company therefore adopted the next best course, using a tunnel tail-race paralleling the canal head-race of its older rival and an artificially constructed gorge of its own to serve as a wheel-pit. This construction is naturally very expensive, and unfortunately, owing to the slope given the tunnel necessary to give a large capacity without too high cost, loses about one-third of the total head.

Many other plans have been proposed, among them wheel and dynamo chambers excavated from the rock below the river bed itself, or islands within it, and another proposed by F. M. F. Cazin, notable for its originality and many attractive features, embodying a pressure tunnel or penstock tunneled from the head of the rapids above to turbines or impulse wheels on the shore of the gorge below,* giving absolutely the shortest running practicable on the hypothenuse of the triangle, one side of which is the vertical fall and the other the lateral distance necessary to include the drop in the rapids.

In spite of the fact that the two companies already at work can supply the demand for many years to come, and with all the ad-

*See THE ELECTRICAL WORLD, July 17, 1897.

vantages accruing from low cost of hydraulic equipment in one case and from operation on an enormous scale in the other, there is now proposed a third development, the general principles of which were outlined by Mr. John Birkinbine, the consulting hydraulic engineer, in a paper read recently before the Engineers' Club, of Philadelphia. This proposes to make use of the waste water of the falls proper in its passage through the whirlpool and lower rapids, the total drop from the gorge at the foot of the falls to Lewiston, on Lake Ontario, being about 100 feet. A large part of this is localized at two points, respectively known as the whirlpool and the lower rapids. The fall of 45 feet in the former would be, according to this paper, first made use of by means of a canal one mile in length along the American shore, taking its water at a point a few hundred feet below the International Railway bridges, with a capacity of 10,000 cubic feet per second, which is about 5 per cent. of the estimated total flow. With a moderate drop in the canal this would make available 35,000 mechanical horse-power, at a head fairly well suited to the direct driving of large electrical generators. The costly wheel-pit and tunnel of the other plan would be offset by the rather expensive canal, the construction of which, judging by the difficulty of the work on the gorge road, would prove difficult, and work on which no estimates of cost could be made. The proposed plan is to separate the canal from the stream by an embankment or wall of concrete or masonry, which would also carry the road-bed of the Niagara Falls & Lewiston Electric Railway, the present route of which would be largely taken up by the new waterway. Undoubtedly some such development will be valuable when the existing franchise rights to the use of the falls proper are entirely used, and the demand for power meets the opposition of those favoring the maintenance of the remaining flow over the falls for æsthetic purposes, but at present the plan seems a little premature.

THE DEMAND FOR ELECTRICAL ENGINEERS AND ELECTRICAL ARTISANS.

There will be found on other pages of this issue an admirable paper by Arthur A. Hamerschlag on "The Education of Electrical Apprentices and Journeymen," in which the fact is pointed out that there is a much greater demand for electricians (to use a term which seems to be comprehensive of both) whose work is manual than for those whose work is mental. This is perfectly natural, and a feature common to all branches of engineering, as is another condition which unfortunately makes a bad combination with it, and that is the natural ambition of all entering electrical work to join the latter class rather than the former.

To the layman believing that "electricity is still in its infancy," the promise of future enormous development of the electrical industries indicates a great demand for technical engineers, which, with the natural inclination of most youths to electrical toys and tinkering, determines the fond parent on a course of electrical engineering. Unfortunately, the electrical field exhibits a peculiarly small demand for high-grade engineering work considering the rapidity of its development, the reasons for which do not seem to be clearly understood. An analysis of these reasons brings up the question, Is electricity still in its infancy? which we are glad to discuss here in order to give an answer to the frequent inquiries received on this point. Like other vague general questions, it may be answered both in the positive and the negative. In one sense, referring to the use and application of electrical methods, the electrical industries are undoubtedly in their infancy; in another sense, referring to the development of the science of electrical engineering, the development is greater than that of many older industries. The principles of electricity are better understood than are those of that much more familiar form of energy, heat. The performance of a new design of dynamo can be predicted with greater certainty than can that of an equally new form of steam engine. Electrical apparatus has reached a remarkable state of standardization compared with the apparatus of any other industry, owing to the simplicity of electrical laws and the great amount of study that has been given to the subject during the last fifteen years. Thus the electrical engineer finds little chance for the exercise of his technical ability. The development of the industry is also rapidly coming into the hands of a few large corporations, so that capitalists or others planning new electrical work find it unnecessary to retain technical consultants, but can leave the planning and construction of complete installations to one of these large companies under a guarantee of successful operation, the engineering staff of the company doing all the technical work. The conditions of civil, mechanical and mining engineering are different. The design of a bridge, of a large steel building, or of any industrial works involves the decision of many questions in which an error would be very serious and requiring, therefore, the best judgment. On the other hand, the installation of a system for the electrical distribution of power, for example, requires the selection of generators, lines and motors, all standard apparatus which can be left with much greater safety to persons of limited training. The demand for technical knowledge is thus limited largely to the maintenance of the engineering staffs of the large companies, positions on which, owing to the large supply, are not very remunerative. Moreover, engineers in other branches are being forced to themselves pick up sufficient electrical knowledge to enable them with the assistance of the companies to do away with consultation on electrical questions. This is owing to the fact that electrical methods are coming into such general use in such branches as railroad work, mining, ship building, etc., that the engineer in one of these branches must himself become proficient in electrical engineering or lose his value.

Men with a technical education are for these very reasons being crowded out into commercial careers or other professions, where their engineering attainments are not of direct use, but are proving of far greater value than do the more conventional classical trainings. There is no reason why a study of the laws of nature as shown even in the applied sciences should not prove a mental exercise as broadening as a study of the dead languages, and the grounding in these fundamental principles—now that all industry is becoming more and more dependent on science—is of great value to a man in almost any business career. For this reason, while the acquisition of a technical education as a preparation for a life work may be discouraged as a substitute for the so-called college course, such an education may come into great and wide favor.

The Next Convention of the National Electric Light Association.

The twenty-second meeting of this association will be held in New York city on May 23, 24 and 25. Headquarters will be at the Murray Hill Hotel, Fortieth Street and Park Avenue, where the rates will be $3.50 per day and upward on the American plan, and $1.50 per day and upward on the European plan. The Electrical Exhibition Company will hold an exhibition in Madison Square Garden during the month of May, under the auspices of the association and in connection with the meeting.

Improvements in Telephone Cables.

Referring to the patent issued to Mr. Stephen D. Field on iron wires stranded into telephone cables, described in The Electrical World of December 24, 1898, page 675, Mr. Rudolph M. Hunter writes, calling attention to his patent, No. 272,441, issued February 28, 1883, which he claims covers the same arrangement. Mr. Hunter's patent describes a multi-conductor cable with uninsulated lines interspersed between the insulated conductors, the whole being woven together by cross strands of metal. The purpose of this design was to introduce a sort of induction shield between the different conductors in order to eliminate the mutual induction between the lines rather than, as in Mr. Field's patent, to increase the distributed self-induction of a twisted pair.

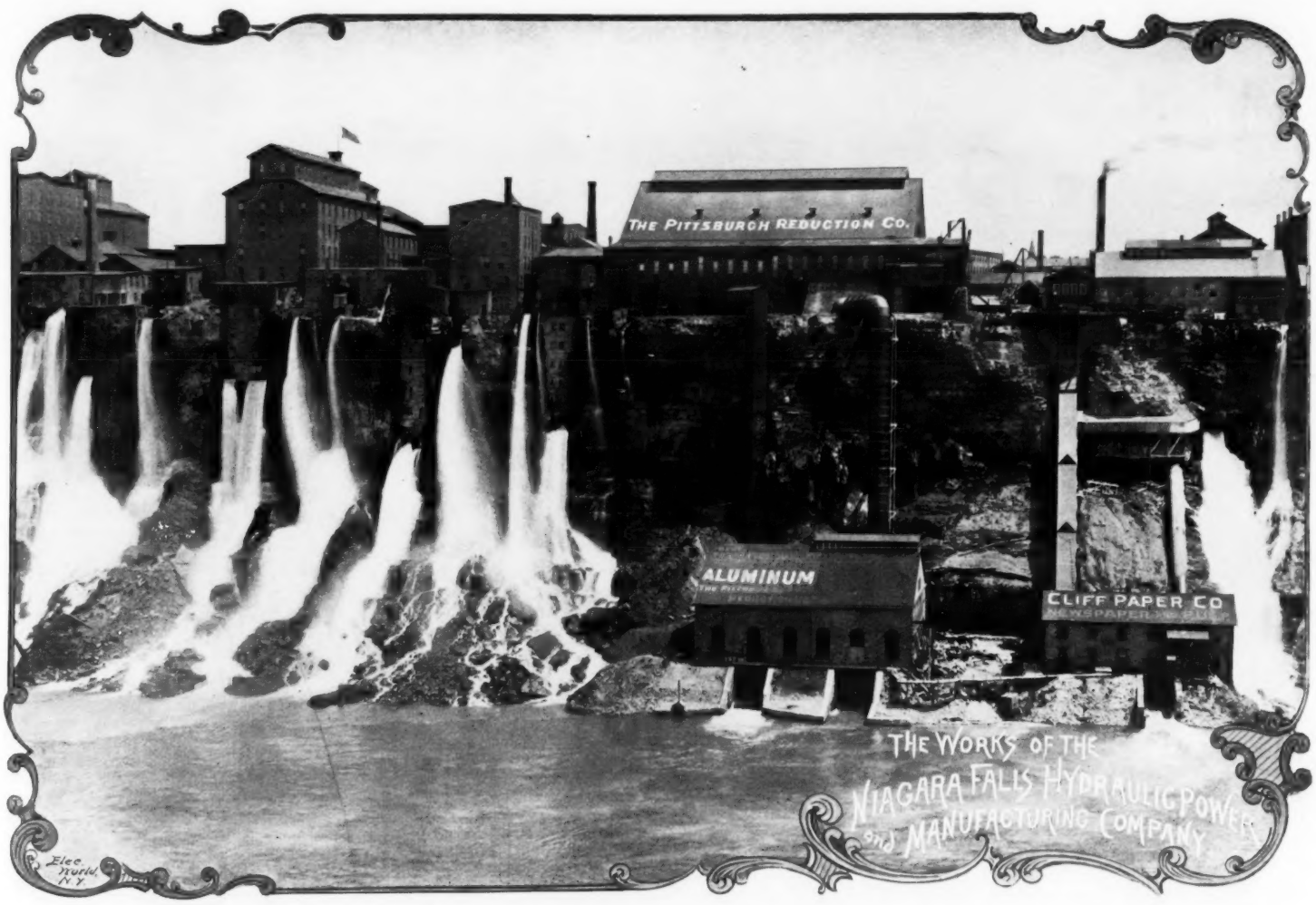
The Power Plant of the Niagara Falls Hydraulic Power and Manufacturing Company.

NEXT in electrical interest to the mammoth plant of the Niagara Power Company is the installation owned by the Niagara Falls Hydraulic Power and Manufacturing Company, on the shore of the gorge below the falls. The hydraulic system of this plant is laid out on more conservative lines than that of its nieghbor up the river, and is certainly subject to far lower fixed charges per kilowatt output. The company utilizes a canal through the town, originally built many years ago, and from which power was first derived in 1858. The plant came into the hands of Mr. Jacob Schoellkopf in 1872, and was put into the general management of his son, Mr. Arthur Schoellkopf, these gentlemen being still respectively president and general manager. This was the first Niagara power developed, and at the start was worked with a separate wheel for each consumer. The Messrs. Schoellkopf, however, early found that central production of power and its distribution in some form or other was more satisfactory, and in 1881 had in use what might be called a central station, distributing power by belts, shafts and rope drives to a number of factories clustered about the edge of the cliff. Water was then utilized with an effective head of only about 50 feet; and great were the troubles experienced when it was attempted to work with a 75-foot fall. The company has been steadily at work, however, advancing its designs as fast as the improvement of the mechanic arts would allow, and in spite of the time it has been at work, has now a modern and up-to-date installation.

Those who have visited the locality will remember the miniature falls below the suspension bridge from the wheels of the various flour and other mills taking from this canal. The company's franchise allows it to draw as much water as it can through a canal 100 feet in width and 14 feet in depth. With only a 2-foot fall from the river level above the rapids, the line of the canal being 4400 feet in length, this gives a capacity of 125,000 hydraulic horse power, the system being such that practically the whole head, which is normally 216 feet, is effective at the wheels. The draft tubes are sealed behind a small dam, which loses two or three feet at the tail-race, which, with the two feet lost in the canal at full load, are the only losses, that due to friction in the penstock being immeasurably small.

At the water's edge in the gorge, almost vertically below the end of the canal at the face of the cliff, is the newly enlarged power plant of this company. The water front for about a mile along the gorge is owned by the company, which will probably some time have a battery of many great penstocks running down the face of the cliff. The original equipment installed here several years ago has been often described and illustrated in print, and but a brief mention of it will be made here. It consists of an 8-foot penstock, feeding four 2000-hp horizontal shaft Leffel turbines, each coupled to two 560-kw direct-current generators. These wheels are each regulated by a Lombard "Type C" hydraulic governor, working with water under penstock head.

Two of the dynamos are 500-volt machines, one supplying the Lewiston & Youngstown Electric Railroad, one end of which is 7 miles and the other 14 miles from the power house. Voltage is maintained at the end of this long feed by means of a booster belted to the wheel shaft. The other three wheels are each coupled to two 300-volt machines owned by the Pittsburg Reduction Company, which has at the top of the cliff a plant for the production of aluminum, absorbing about 3,000 electrical horse-power. The conducting leads running up the hillside to this plant are all made of

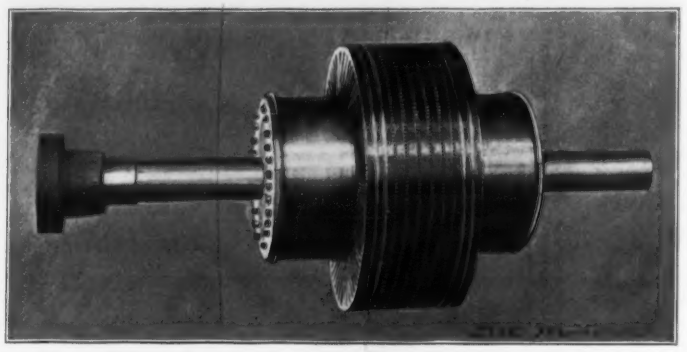


aluminum rods gathered into cables. The Niagara Falls Hydraulic Power and Manufacturing Company's system differs generically from that of the Niagara Falls Power Company, in that it is laid out on the general plan of generating the power in the form in which it is wanted, instead of generating one uniform kind and transforming it to the styles wanted.

The most interesting part of the equipment, however, is the mammoth new penstock which has been added during the last year. This, as shown in the initial of this article and the illustration below, runs out boldly from the face of the cliff in a horizontal direction for a distance of 60 feet, then makes a quarter turn and drops vertically 200 feet, again making an easy turn to run horizontally under the floor level of the power house. Its diameter is 11 feet, enlarging to 13 feet at the lower bend and tapering as it passes the five 5-foot gates, which point upward through the power-house floor. But one of these gates is now utilized, the other four being available for the addition of more machines, the one in service being that nearest the penstock terminal, there being beyond it only two smaller gates intended for exciters when alternating-current machines are installed in the station. This penstock is probably the largest, or at least the heaviest, in the world. Some 250 tons of steel were used in its construction, the shell being 1⅛ inches in thickness at the lower curve. Its design and construction presented many original problems, the satisfactory solution of which reflects no little credit on the ability of the hydraulic engineer in charge, Mr. W. C. Johnson.

The upper horizontal part is supported on two heavy girders, one to either side, and is surrounded at frequent intervals, as the illustration shows, by rings of an I-beam cross-section drawn up by bolts, the purpose of these being to prevent the collapse of the tube, which is at this point thin, from its own weight and that of the water within it. The vertical length is supported entirely from below by brackets riveted to the penstock and standing on supports of cut-stone masonry.

No provision has been left for temperature changes, it being estimated that these would be slight owing to the fact that the penstock is always carrying water of a very uniform temperature, and the upper right-angle bend will give a slight flexibility. The five gates, four of which show clearly in the general view of the interior of the power house on the opposite page, are worked by hydraulic rams under the penstock head, and are each fitted with three by-pass valves. This lower horizontal part of the penstock is hung on steel saddles, supported by frames, bolted together with wedges for adjusting them both vertically and laterally, and is securely stayed to the concrete foundations by heavy tie rods. It terminates in a cone-shaped end with thirty-six 6-inch spring relief valves set to open at 100 pounds' pressure to the square inch, a view of which is shown on the opposite page. To further allow for the inertia of

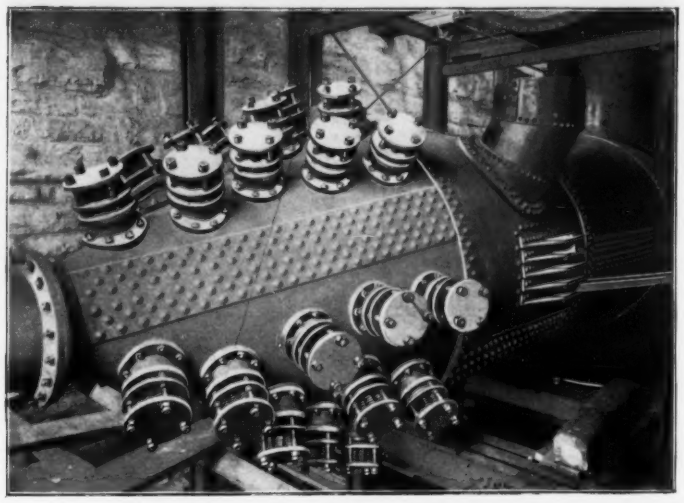


The Armature of the Double-Commutator Dynamo.

A View of the Great Penstock, Looking Toward the New Suspension Bridge and the Falls.

the descending water on reducing load, there is an air chamber 4 feet in diameter and 12 feet high connected to the end of the receiver, as well as one on the top of each wheel, all being piped to a motor-driven air compressor.

The one turbine on this penstock is of the Jonval horizontal-shaft

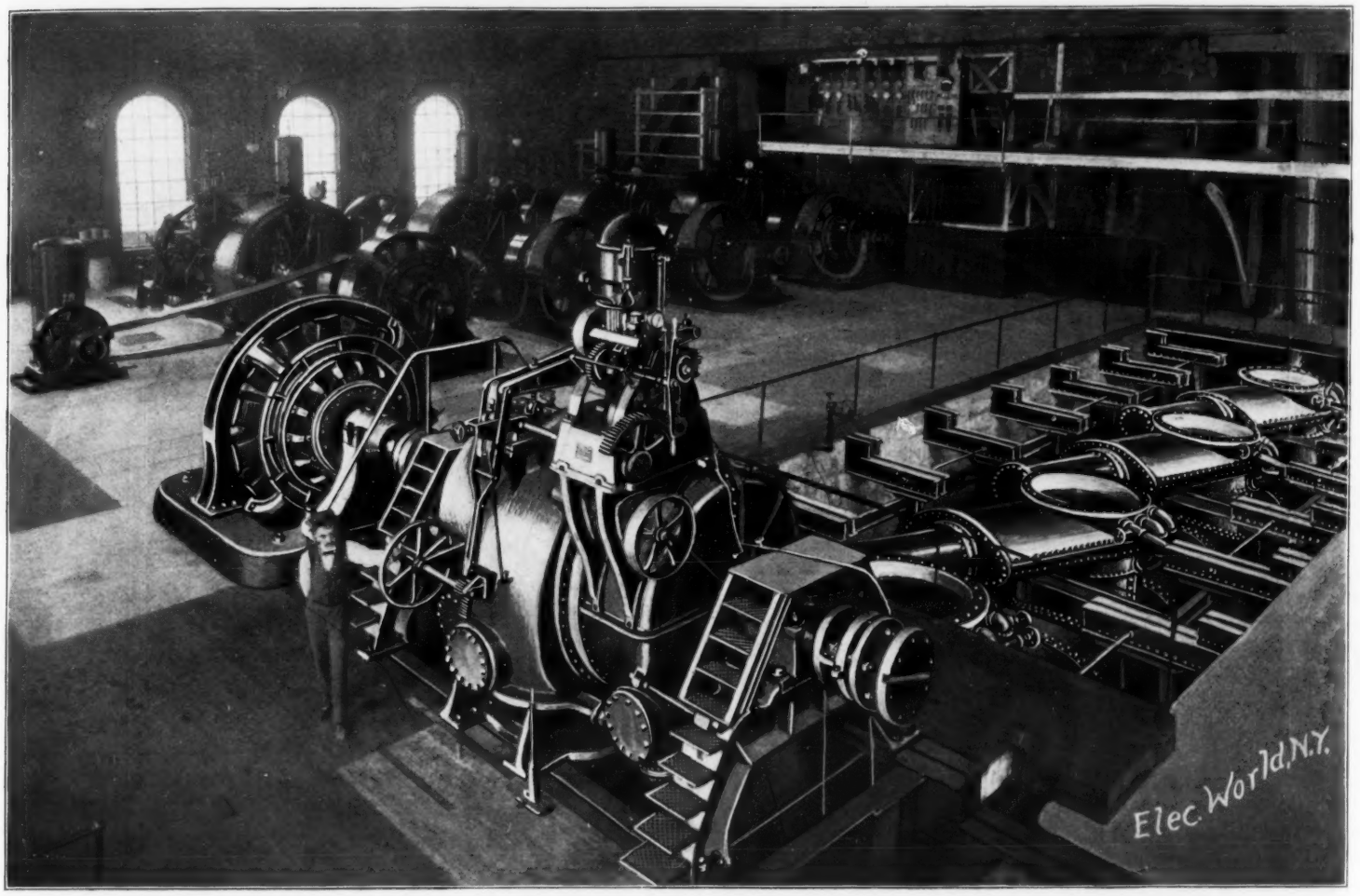


THE RELIEF VALVES ON THE END OF THE PENSTOCK.

type, and was built by R. D. Wood & Co. It contains two axial-flow wheels with a common central intake and quarter-turn draft tubes running down to and sealed in the tail-race below the floor. The nature of the passages through the runners and guide chutes is clearly shown in the illustration on page 46. The speed control is effected by a register gate, through which the water passes before it reaches the guide chutes. This gives a somewhat lower efficiency on part gate than does a gate interposed between the guide chutes and runner buckets, but economy of water at part gate is no particular object in this plant, and reduced efficiency is; in fact, an advantage, in that it reduces the gate movement and the change of velocity in the penstock with a given change of load, and consequently reduces the inertia action and aids the speed regulation. The gate is controlled by a device on top of the wheel which looks like a walking beam, which is in turn operated by a Reynolds pneumatic-mechanical governor. The big turbine is rated at 2500 horse-power, at 250 r. p. m. under the normal head of 210 feet, and is at present only coupled to one of the two machines which it is capable of driving.

This one machine is a General Electric, 14-pole, direct-current generator, capable of delivering 5000 amperes at 175 volts. For the rectification of this enormous current, two commutators, one on either end of the armature, are provided, connected with two electrically independent bar windings laid in the same slots. The field is shunt-excited only. The two sets of brushes are connected up in multiple with each other. Proper division of current between the two is ingeniously effected by slightly varying the lead of one or the other set of brushes, a Weston central-zero ammeter connected to a Y shunt being mounted on the machine, convenient to the brush-rocking wheels, so that this adjustment can be accurately maintained at all times. The generator is controlled on a panel of the switchboard in the gallery overlooking the station, its output being delivered to the plant of the National Electrolytic Company, of whose work a brief account will be found on the next page.

The 5000 amperes are conveyed to the latter company's works with a drop of less than 10 volts over a line between terminals 800 feet long, built of aluminum, but unlike that running to the Pittsburg reduction works, which is of aluminum rods about one-quarter of an inch in diameter, twisted into great cables. This line is of strips 25 feet in length and with a cross-section 6 inches by ½ inch, four of these, with an aggregate cross-section of 12 square inches,



AN INTERIOR VIEW OF THE POWER HOUSE, WITH WHEEL AND GATES OF THE NEW PENSTOCK IN THE FOREGROUND.

being on each side of the circuit. The line passes vertically up beside and is supported on the large penstock, as is shown in the general view on page 43.

The eight ends of the two adjacent lengths of one polarity are in-

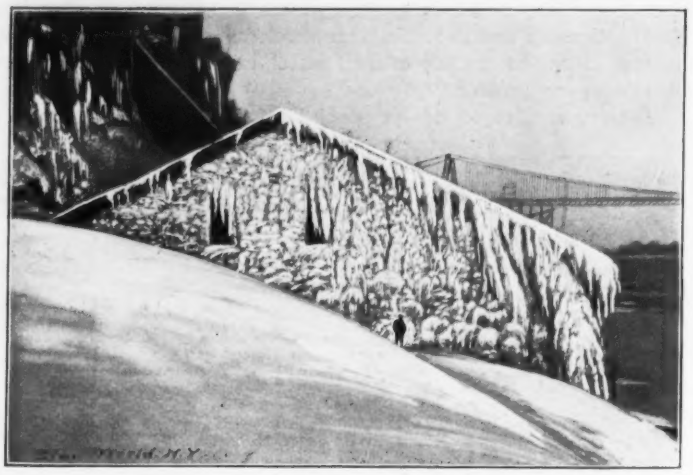
terleaved and lapped upon each other and fastened together by aluminum rivets, as well as by heavy bolts, which also pass through flattened sections of two 1½-inch round iron rods, which are each bent into a stirrup shape. These two stirrups rest on the heads of two screw-cap fibre insulators, mounted on pins on an angle-steel framework attached to the penstock. The line was put up last summer and left with considerable slack, sufficient to allow for thermal contraction without stretching the lengths at the lowest probable temperature. Slight changes in length make, of course, quite a considerable bulging or sagging of these long bows, and their change of shape with the weather is quite noticeable. Before another warm spell comes around the middle of the lengths will be fitted with slate slabs to prevent the positive and negative sides from bulging sufficiently to come together and cause a short circuit.

Work is satisfactorily under way for the extension of this power plant, another 11-foot penstock already poking its nose out from the hillside above, the masonry work for the raceway to this penstock now being under way. The work will be advanced more or less hurriedly, according as the negotiations now being carried on for the sale of further large units of power result favorably or otherwise. The company owns property along the shore for a distance of about a mile, and has, as noted above, the rights for a canal capacity sufficient to supply ten such large penstocks, each delivering 12,500 horse-power.

The Electrolytic Production of Chlorate of Potash.

The output of the large generator in the plant of the Niagara Falls Hydraulic Power and Manufacturing Company, described above, is absorbed by the plant of the National Electrolytic Company, which uses 1100 horse power continuously, day, night and Sunday, in the electrolytic production of chlorate of potash. This plant is the only one of its kind in the country; in fact, the only plant at present producing chlorate of potash in this country under any process, although there are other electrolytic plants for the same purpose in Switzerland and Sweden.

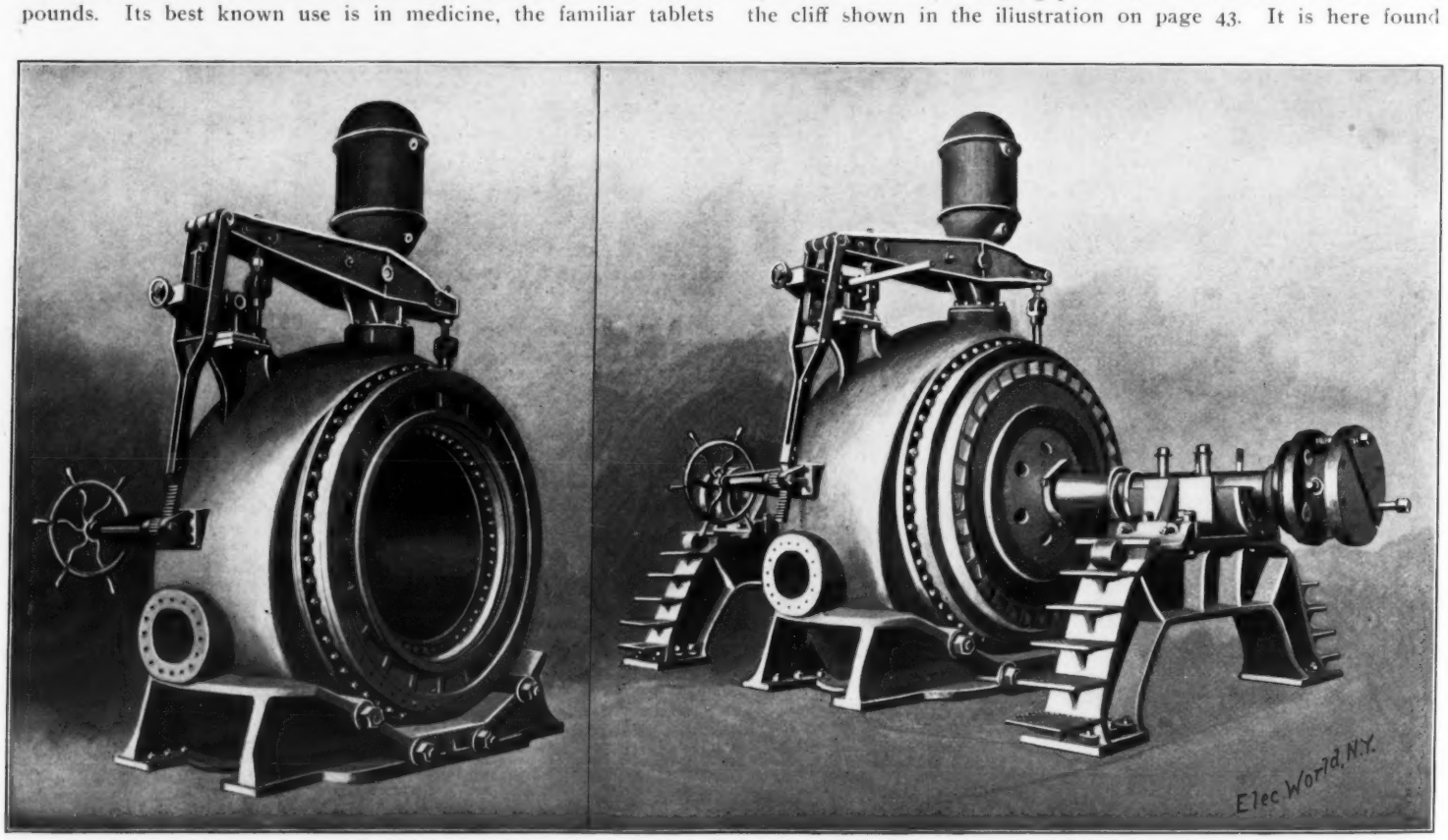
The importation of this material during the year 1897 was 6,200,000 pounds. Its best known use is in medicine, the familiar tablets for sore throat, etc., giving a great demand. It is also used in the manufacture of matches and the dyeing of calico, in caps for toy pistols, in fireworks, where it gives a purple flame, and in that most violent of explosives, rack-a-rock. The raw material for all chlorate of potash by all methods is chloride of potassium, the one source of this raw material for the whole world being in Stassfurt, Saxony. The electrolytic process uses no intermediate reagents, the oxygen necessary for the chlorate being derived directly from water, a material existing in considerable quantities at Niagara. This direct method gives a product of great purity, a consideration of no small value in medical work. The process used by the National Electrolytic Company is the invention of Mr. W. T. Gibbs, of Buckingham, Quebec, and its operation so far has been most remarkably successful. The company is about to double its present equipment. The technical details of the process are kept secret.



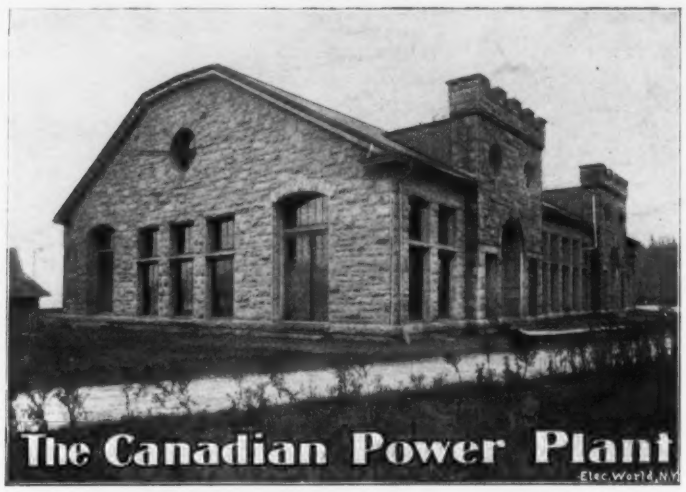
The Power House in Winter.

The Electric Circuit as an Elastic Coupling.

The mill of the Cliff Paper Company, of Niagara Falls, is driven by electric motors, obtaining power from the house at the foot of the cliff shown in the illustration on page 43. It is here found that the electric transmission gives an elasticity and comparative smoothness of working sufficiently superior to mechanical connection between the paper machines and the driving turbines to make electric transmission advisable, even for the shortest distances.



Views of the New Jonval-Type Wheel, Showing Guide Chutes and Bucket Ring.



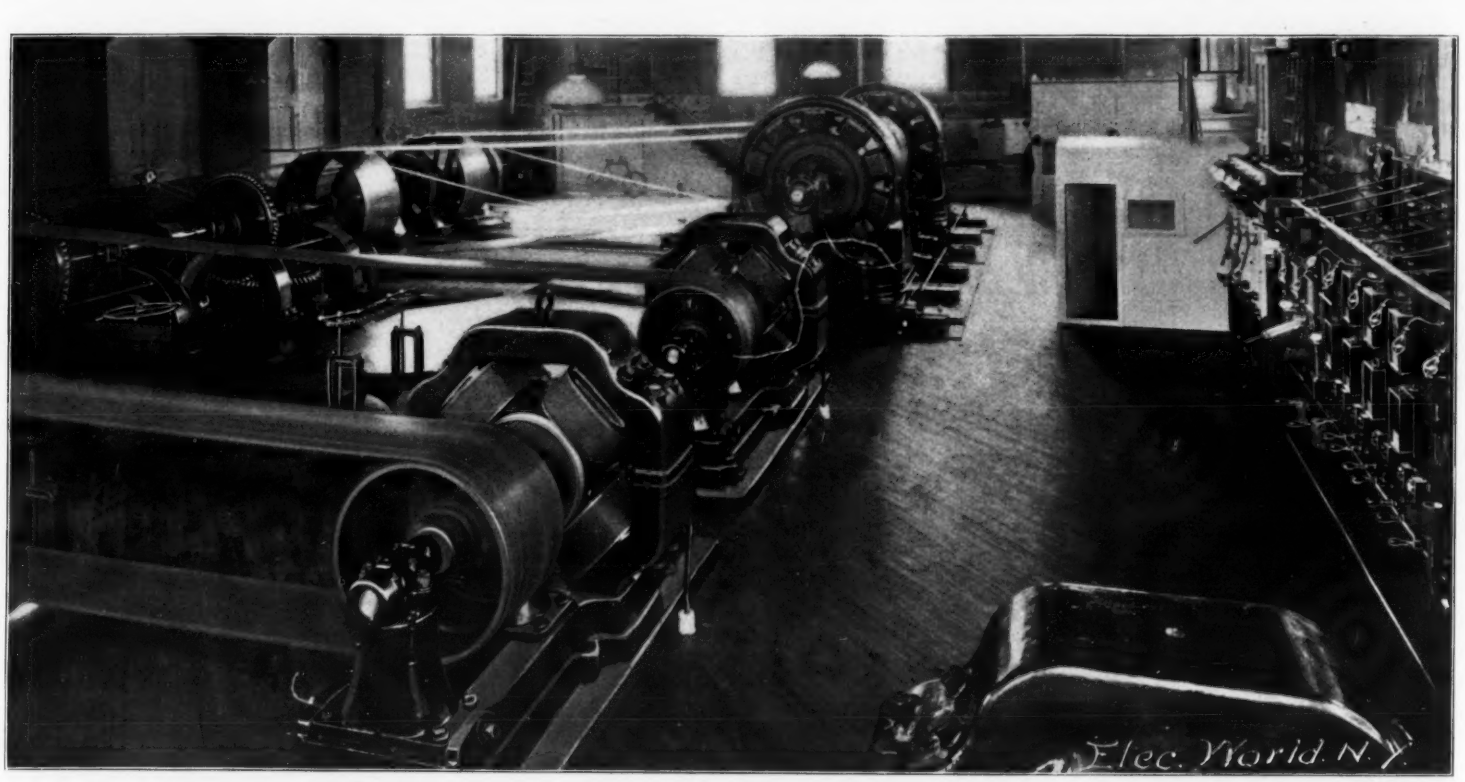
On the Canadian side of the river there is but one hydraulic power plant in operation, supplying power to the lines of the Niagara Falls Park and River Railway Company, and equipped also with two generators belonging to the Canadian Niagara Power Company.

The power house, a view of which appears at the head of this article, is a picturesque structure, situated in the Queen's Reservation, just below the bluff, at the head of which is the Falls View station of the Michigan Central Railroad, and immediately inshore from the furthest up-stream portion of the Horseshoe Falls. Toward the river a short head-race gives still water for the vertical penstocks, of which there are two, each 7 feet in diameter. The water is utilized under a head of 60 feet only, and discharges into a tail-race 8 feet wide and 10 feet high, tunneled out 700 feet with a 15-foot fall to the face of the cliff, where at times of low water its orifice may be seen just under the Canadian edge of the sheet pouring over.

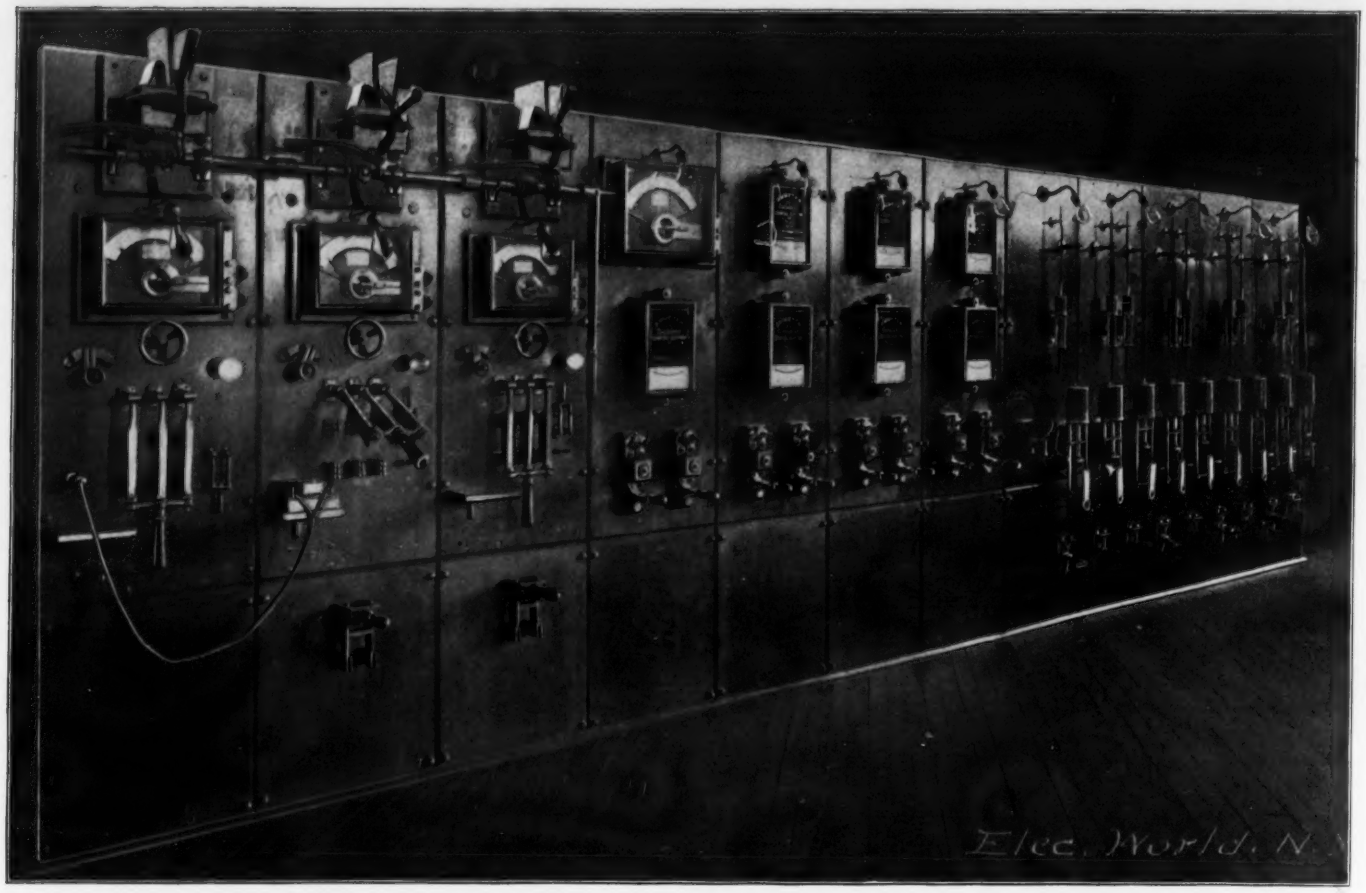
There are in service two "New American" turbines, on vertical shafts, concentric with the penstocks, the shafts running up through the centres of the penstocks to the surface. These wheels are of the inward radial-flow type, with axial discharge, and the well-known graduated guide chutes as made by the Dayton Globe Iron Works Company. The runners are 45 inches in diameter, run at 200 r. p. m. and are rated at 1000 horse power. Keyed to the top of the turbine shafts above the power-house floor are bevel gears about 4 feet in diameter, transmitting the power to a horizontal line shaft. The teeth of one of each pair of bevel gears are of wood, and of the other of cast iron. The line shaft is divided between the two gears by a coupling which normally is uncoupled, giving one wheel the railway load, which is belted entirely from one-half of the line shaft, and the other wheel the alternating load. The interior of the power house presents a rather odd appearance, the equipment being a strange mixture of the new and the old. The universal use of the overhead traveling crane is proven by the immediate attention which its absence in this plant creates.

The railway equipment is of a very primitive type, about such as might have been found in service in the average town of the United States about six years ago. It consists of three 4-pole 200-kw. rectangular iron-frame machines, belt-driven, installed by the Canadian General Electric Company, and all kept constantly in motion no matter what the line load may be, as there are no clutches or loose pulleys for throwing any one of them out of service.

The switchboard is equipped with three genrator panels at its right-hand end, with the old-fashioned lightning arresters, current indicators and switches, which the accompanying illustration clearly shows. The right-hand end of the board contains a rather interesting equipment, consisting of nine so-called electric controllers. They consist of solenoidal switches, each of which throws across the line a resistance of 10 ohms, taking therefore, about 50 amperes. The purpose of these machines is to insert more or fewer of these dead resistances in inverse proportion to the load upon the line, making the total load on the machines constant. Each solenoid is controlled by a small solenoidal relay, with a fine wire winding connected across the mains, which closes its circuit through the main solenoid whenever the voltage exceeds a certain limit. These relays are so adjusted that they operate at slightly different voltages, in order that they shall all not move simultaneously. The main controllers have heavy carbon moving terminals, making contact with fixed copper terminals below them. The duty of this part of the equipment is, of course, to avoid the necessity for governing the water wheel, the gate of which is simply controlled by hand. Enough generators are at any time running to handle any probable peak of the load, with a gate opening sufficient for the same, and enough of the controllers in operation to take up any probable difference between the external load and the output of the machines with that gate opening. As the current taken by the cars rises and falls, slight variations in voltage affect the controller relays so



THE INTERIOR VIEW OF THE POWER HOUSE.

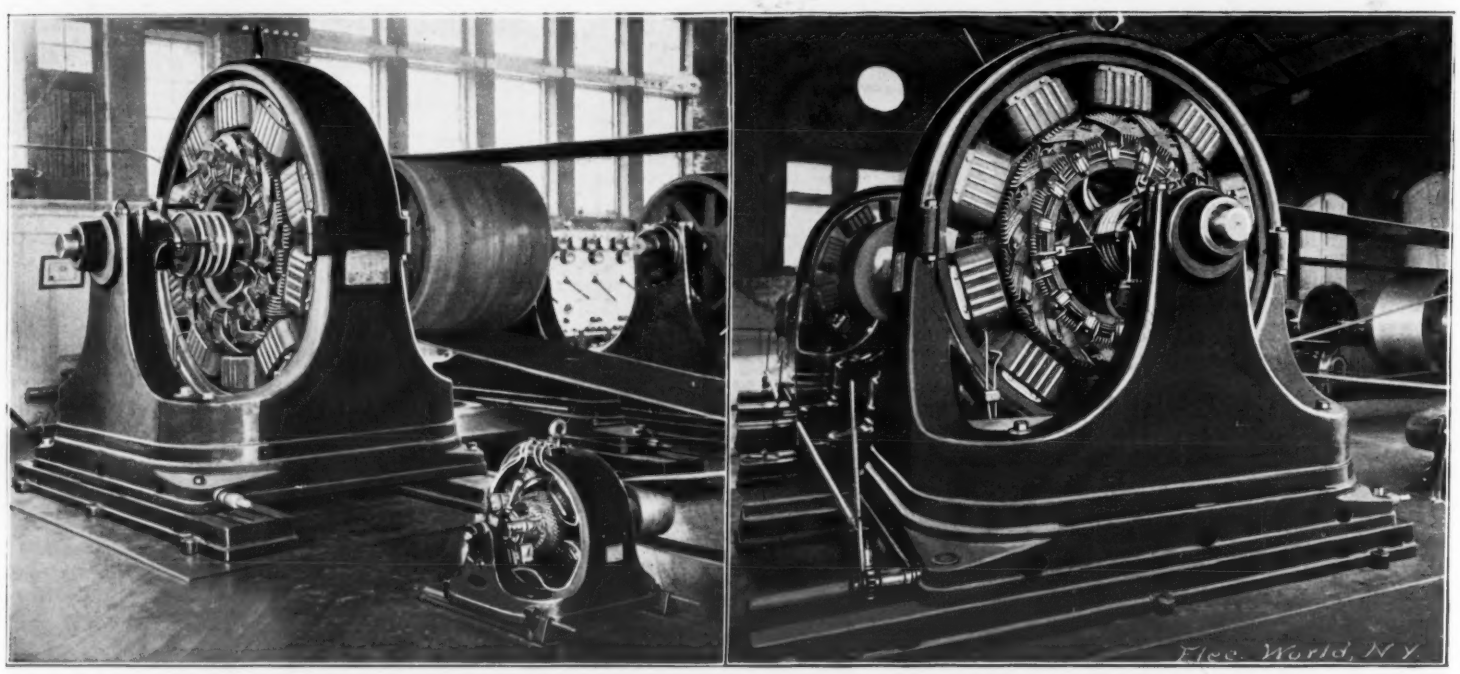


The Switchboard of the Railway Plant, Showing Electric Controllers at the Right.

that the current taken by the controllers falls and rises, maintaining the machine load practically constant.

The installation of the Canadian Niagara Power Company is less medieval in character. The machines, two views of which are shown on this page, are 3-phase, 25-cycle, 2400-volt, 10-pole alternators, made by the Westinghouse Electric and Manufacturing Company. They are driven at 300 r. p. m. by 44-inch belts, the pulleys being inside the outboard bearings. The winding of these machines is quite interesting, consisting, as it does, of six slots per pole per phase, wound with Eickemeyer formed coils of copper ribbon, bent down over the ends of the armature and held in place by V-shaped castings screwed to the end plates. The three phases are connected in a Y, or star, grouping, the connecting rings—one of which is the common point of the Y, the others connecting in series the different groups of coils of each phase—running around the face of the armature, as shown clearly in the illustration. The air gap is about three-quarters of an inch in length. Two small four-pole exciters are also belted to the main shaft.

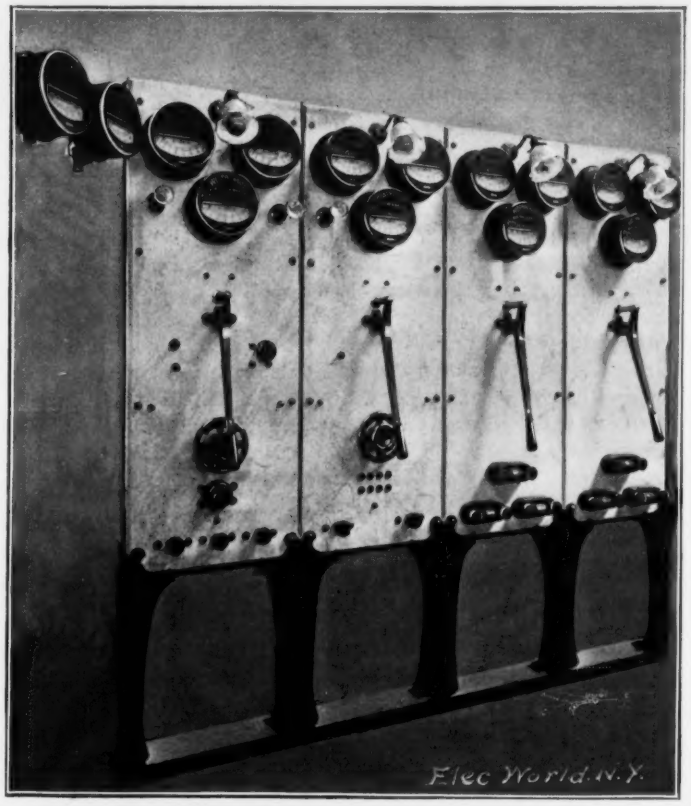
The alternating switchboard, views of which appear on page 49, is remarkably simple and neat, considering the amount of apparatus which it controls. It consists of two machine panels at the left and two-line panels at the right, each panel being fitted with three ammeters, one in each phase, and three combined knife and plunger-type switches. The handles of these are on the face of the board, and immediately at the rear are the plungers, in lignum vitae cylinders, while at the top of the panels behind the board are knives which are mechanically connected with the plungers and give a low-resistance contact, the plungers giving a high-resistance



Two Views of the Alternating-Current Machines.

following break. The line panels are also each equipped with three fuses in lignum-vitae enclosures. The two machine panels contain also the controlling and switch devices for the exciters. The exciting field rheostat handles may be seen concentric with and smaller than the main rheostat handles, and the exciters are switched in and out by means of the transfer plugs at the bottom of the panels. Immediately above these are three-position voltmeter plugs, by means of which a bracketed voltmeter may be connected across any phase, and still higher up on one panel is a three-position ground-detector switch.

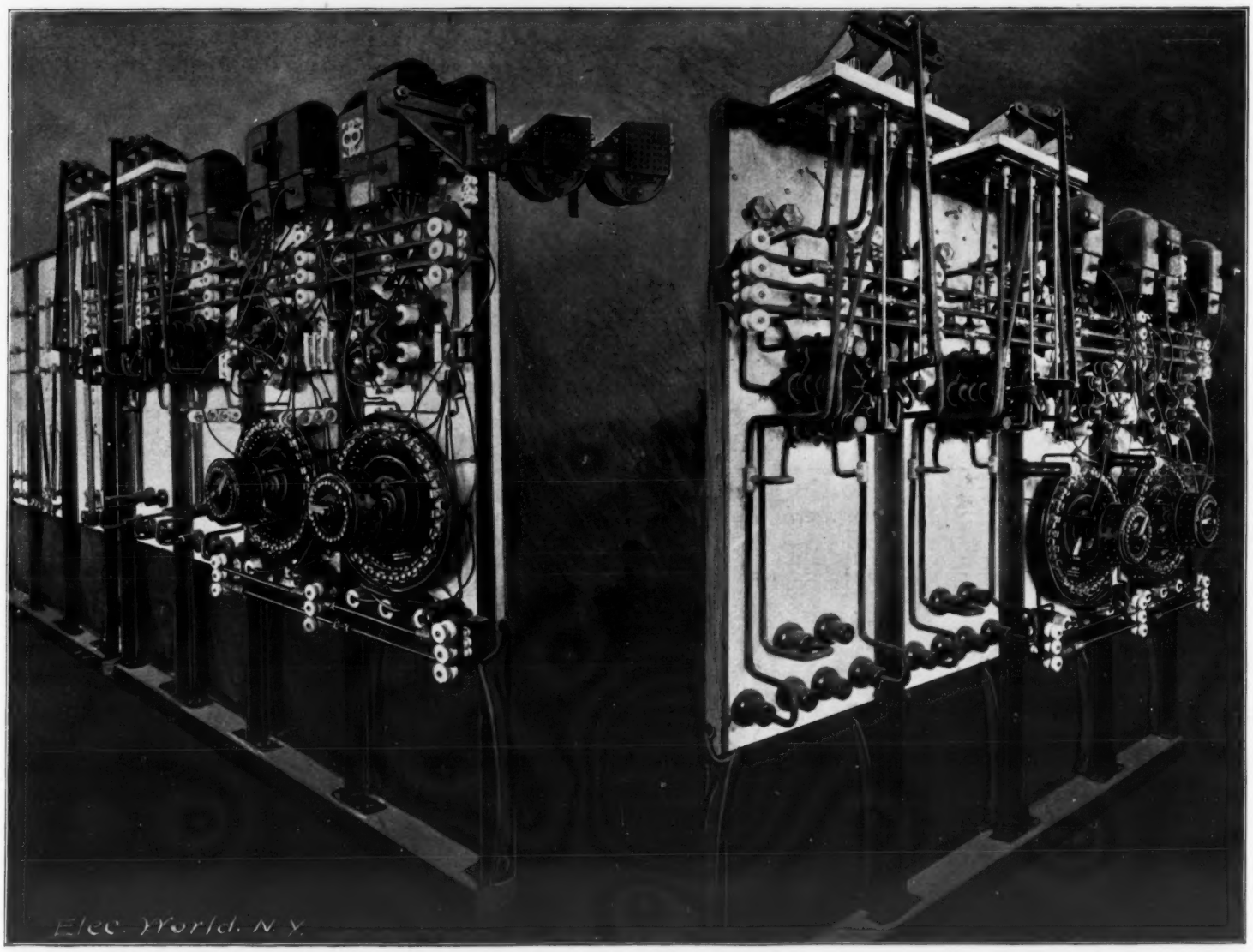
The load on this part of the plant is a small one, its only warrant for operation being the requirements of the exclusive franchise of the company to the Canadian shore. The generators carry a small carborundum plant and at night drive a central station lighting the town.



A FRONT VIEW OF THE ALTERNATING-CURRENT SWITCHBOARD.

Another Development of Niagara Power Planned.

A Buffalo syndicate proposes to construct a hydraulic and electric plant in the Niagara Gorge, to develop about thirty thousand electrical horse-power. A canal about a mile long is to be constructed along the bank of the New York side of the river, extending northerly from the cantilever bridge. This will necessitate the reconstruction of a considerable part of the Niagara Falls & Lewiston Railroad, popularly known as the Gorge Road. Mr. George A. Ricker, of Buffalo, is resident engineer, and has made a complete survey of this part of the gorge, and has prepared plans and estimates of the proposed development. Mr. John Birkinbine, of Philadelphia, president of the Franklin Institute, is consulting engineer, and has presented a paper upon this subject to the Philadelphia Engineers' Club, Jan. 7, 1899.



TWO VIEWS OF THE ALTERNATING-CURRENT SWITCHBOARD FROM THE REAR, SHOWING COMBINED PLUNGER AND KNIFE SWITCHES.

A Photographic Study of the Electric Arc.*

BY N. H. BROWN.

If a photographic plate or film is moved rapidly in front of a lens or camera, in such a position that the image of some object is thrown on the sensitive part of the plate, an impression will be produced on the plate which is a more or less perfect history of the changes that took place in that object while the plate was moving. If the image is quite broad there will necessarily be much blurring of the plate, causing lack of definition.

Various attempts have been made to learn something about arc light by photographs taken in this way when the arc was undergoing some variation. The pictures obtained have been interesting, but have lacked the definition which usually characterizes a photograph. Naturally, the alternating current has been best adapted to this study, for the changes are fairly uniform and frequent. The advent of the alternating-current enclosed arc lamp has furnished an arc that is much steadier in its action, and, therefore, more uniform in its variations than any previous arc, and thus better adapted to this work. For this reason most of the work described in this paper was carried out with the aid of such a lamp.

We shall consider the various types of photographs connected with this work, discussing each as it is described, instead of describing all and following with a general dicussion.

Pictures numbered one (see Plate I) were taken on a sliding plate without a screen, as shown in diagram I of Fig. 1. We find here a marked symmetry not only between the various pictures but between the parts of one picture. Each light spot is like the second, fourth, etc., from it. On closer inspection we notice that if any spot were turned over it would be like its next neighbor. The front end of each light portion is not square across the picture, but makes a very appreciable angle. This seems to indicate not only that the arc was out part of the time, but also that the lighting up did not take place across the whole arc space at the same instant, having started from one side one time and the opposite side the next time. A simple calculation, depending upon the velocity of the plate and the slope of the light front, shows that this light traveled across the arc with a velocity of about 300 inches per second from the negative carbon toward the positive.

In one or two of these pictures we can see slight indications that there is another light front advancing from the positive toward the negative, but we shall see this much more clearly from another set of pictures. The back end of the light space seems to be away from both carbons, as though the light died out near the carbons first, and later near the center of the arc space. This seemed strange, and so led to the fear that the shapes of the front and back ends of the bright portion of the plate were due, in some way, to the shape of the arc itself. For instance, suppose the arc had been conical as it was first lighted, and that the lighting was practcaliy instantaneous. Suppose also that as the arc commenced to decrease in intensity it changed into a globular form. We could then account for the peculiar shape of the arc pictures without supposing that appreciable time was required to light the arc. In order to test this point pictures were taken with a narrow slit placed just in front of the image of the arc on the plate. If a screen, which has a very narrow slit in it, be placed very close to the plate as it is moved in front of the lens, as shown in Fig. 1, diagram II, so that most of the image is cut off, we may get a fairly clear image of the small part that is left. The results obtained in this way are shown by pictures numbered 2, Plate II. From these it is evident that there were two light fronts, one from each carbon, and that one of these light fronts started about 1-1000 of a second before the other.

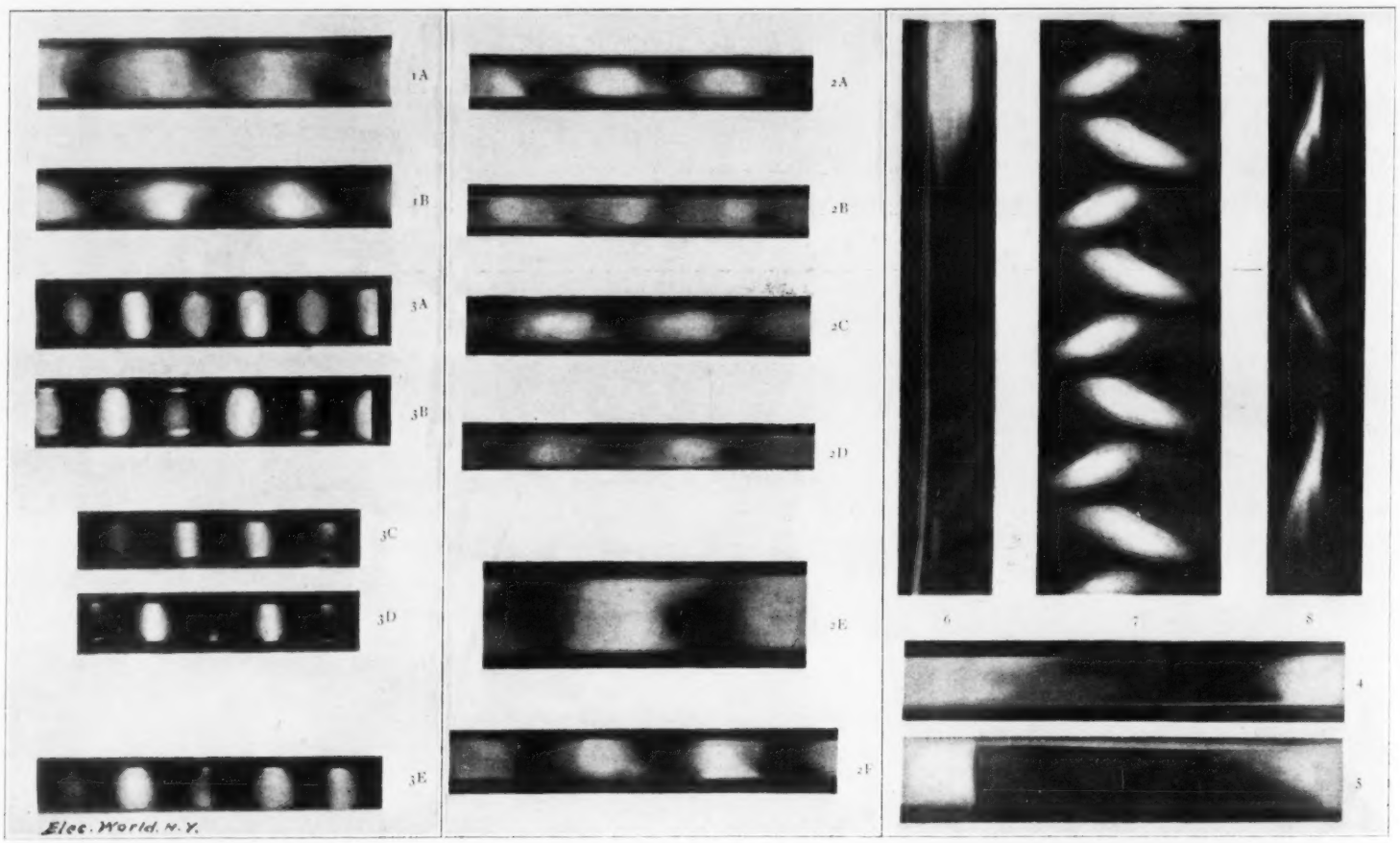


Plate I. Plate II. Plate III.

Their slopes show that they traveled with different velocities, the one from the negative side moving about three hundred inches per second, while the other moved about five hundred inches per second. Some of these plates were under-developed to bring out differences of density more clearly. The slit being left less than 1-64 of an inch wide the outer contour of the arc could have had little to do with the shape of the pictures. Each consecutive vertical section of the picture must be the record for successive intervals of time of that particular vertical section of the arc was thrown on the slit.

Blondel and McMynn, in articles previously published, each showed pictures showing some of the characteristics just mentioned, but the effect was so slight that neither of them noticed and discussed them. By comparing their pictures with these we find from similarity that we are able to easily tell which of the terminals was positive at any given instant, which way the plates were moving, etc.

These conclusions were so striking that it seemed well to get some other results that would verify them, and to attempt to explain why we should get such results. We have assumed that the pictures on Plate II were of some section of the arc. If we could

* Reprint from the "Physical Review."

only take pictures of the whole arc at frequent intervals we could hope for confirmation. But to secure such pictures of the arc as it is at any instant it is necessary, as with everything else, that the movement of the plate be very slight during any exposure, and that the movement or change in appearance of the arc should be very slight. In order to separate the various parts of an alternation as much as possible on the plate it seemed necessary to run the plate at a speed of 40 to 50 feet per second. As a movement of the plate of one-hundredth of an inch or more during an exposure would injure the definition of the picture the time of exposure must be very small. The pictures numbered three (Plate I) were taken with the apparatus arranged to give rapid exposures of the whole arc, as shown in Fig. 1, diagram III. When the disc D was revolved about its axis 15,000 times per minute each of the four slits would cause an exposure which lasted about 1-25000 part of a second. There would be 1000 exposures a second, or about eight images for each complete period (the frequency was about 125).

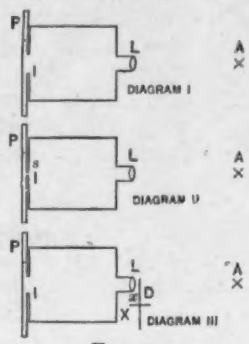


FIG. 1.

The pictures numbered three were taken with various velocities of the disc from 7000 revolutions per minute up. Here we find the arc in all possible conditions, and the conclusions reached by our former method are fully verified. The picture 3D was taken when a magnet was held close to the arc. Here the arc is deflected to one side or the other, depending on the direction in which the current is flowing. At times the last end of the light from one-half period has not faded away when the new light front for the next period has arrived. With the magnet near, the fading light of one period is driven in one direction, while the new light formation due to the next period is sent in the opposite direction. They are thus separated in such a way as to show clearly to which period they respectively belong.

I examined the arc for plane polarization by setting a Nicol prism in front of the arc and taking a number of pictures, rotating the prism a few degrees for each till 90 degrees of arc had been covered. No effect whatever was noted.

Nothing thus far has shown that the formation of the two light fronts on the opposite ends of the arc in the way we have described is not a function of the form of the current curve. To determine this point pictures were taken of a very slow period arc (22 per second). One of these is shown in number 4. They seem to be like the other pictures in all characteristics except that everything is exaggerated somewhat. This current was of the "true sine wave" form, while the others were "peaked." Thus the characteristics are at least not very sensitive to small changes in the wave form. To further vary the type of current a direct current was sent through the arc. This was short circuited during part of the time while the plate was moving across in front of the arc. Before the plate had passed entirely across the short circuit was broken, relighting the arc. This acted in such a way on the lamp mechanism as to rebreak the arc. Thus we had on our plate: First, a steady arc; second, the arc broken almost absolutely instantaneously; third, the arc formed again with very great suddenness and with slightly higher current value than formerly; fourth, the arc broken by the separation of the carbons. These pictures are shown numbered 5. When the arc is first broken a quite abrupt line is visible, showing a very sudden diminution of the light. The fading light from that line forward is as it was with the alternating arc. When the arc is reformed its difference from the alternating arc is very marked. At first sight it seems to be almost square across the end, but, on closer examination, it shows that the light did not reach the center quite as soon as it left the sides. The difference in time is very slight, however, as compared with the difference in the case of the alternating current. Then, too, with the alternating current the negative carbon gives out light first, while here the positive is slightly ahead. The picture number 6 was taken in the same way as its predecessors, except that a very fortunate accident occurred. The second extinction of the arc took place so quickly after the arc formed the second time that the light front only started to form by the time the arc was extinguished. As can easily be seen from the picture the carbon was already moving away when the arc was formed. This leaves no doubt whatever that the light front starts near the positive carbon.

With these data it seems best to advance one or more hypotheses which will account in a more or less satisfactory manner for the phenomena. First, let us suppose that this source of light is due to ions moving across the arc very much as they move in electrolysis; either that the particles actually move with a velocity of the light front, or that the space being filled with particles a wave of change passes with that velocity. We would then suppose that the particles could move from the negative carbon more readily than from the positive. This would be what we would expect from the fact that most of the electromotive force (necessary to send a current through the arc) is overcome very close to the positive carbon. Under these conditions a particle thrown off from the positive carbon would move with a greater velocity than one thrown from the negative. This supposition would account also for the difference in slope on the last end of the light space, as is shown in several pictures, and for the finishing of the light at the center. It would also account for the fact that the light front from the positive carbon is stronger than that from the negative.

The first serious obstacle confronting this hypothesis is the pictures of the interrupted arc shown in numbers 5 and 6. In these the start comes first from the positive side, and the finish is at practically the same point. Here the successive arcs are in the same direction. If now we can advance any hypothesis which will base the point of starting of the light front on the polarity during the preceding illumination the difference in direction between the alternating and direct arcs will be accounted for. Let us suppose that particles being in the space between the carbons the light is produced by heating them. If a current which is very weak at first starts across the arc space it is reasonable to suppose that while it is a weak current its main heating effect will be at the carbon surfaces. Now, if one of the carbons (the negative) is much hotter than the other, that one should show the first effect; hence the light would start from the negative. Then as the current continued and increased the positive carbon would reach and quickly pass the temperature of the negative, and thus there would be a stronger effect from the positive than from the negative, and thus, too, it would move faster. And as the current became greater the direct effect of the current on the gas would become greater. When the arc stopped we should suppose that the solid carbon would dispose of its heat much more rapidly than the gas. This would cause the light to last longer toward the center. This would account, too, for the tardiness with which the light fades out near the positive side. With the interrupted arc, according to this hypothesis, the sudden falling off in the light at the instant of cutting out the arc would be due to the fact that the current was not flowing, and, therefore, there was no source of heat in the gas. The further gradual cooling would be due to radiation or other causes, as in the alternating arc. Here, too, it is natural that the gas should cool nearer to the carbons. When the arc is re-starting it is started with full or more than full current, and the effect of the arc directly on the gas is much greater than when the current is small; hence, we naturally expect the hottest part to glow first and our lights start near the positive carbon, but not quite at the carbon, as shown in number 6.

Photograph No. 7 was taken with the image of a vertical arc thrown on a plate moving vertically. Here we find, in general, that the light moves out horizontally under the influence of a magnet near the arc, and that the direction of this movement depends on the direction of the flow of the current in the arc, but we failed to get sharp definition. Plate number 8 was taken in the same way, except that a very narrow slit was placed horizontally as close as possible to the plate and the speed of the plate was increased. This gives good definition and shows also that while the whole source of light is moved to one side it is not moved uniformly, and thus the bright band is broadened out. The broadening out, moreover, does not leave the light uniform throughout the whole band, but separates it into several different bands, as though the current flowing across the arc consisted of waves of distinctly different frequencies or wave lengths, or was composed of several series of currents where each current of a series differs from the next to it by a very small amount. This band would then correspond to a spectrum in which some broad lines were wanting.

It would be reasonable to assume in this connection that this electric spectrum was in some way a function of the winding of the dynamo or the shape of the field magnets and that it may be modified somewhat by the transformers or inductive resistance through which the current passes.

No definite statement can be made regarding this, however, for all of the pictures so far have been taken under too nearly the same conditions to bring out such differencss. At first thought it seems strange that the consecutive alternations do not appear symmetrical, but this is easily explained when we know that the slit is very close to the image of one of the carbons and a relatively long distance from the other.

Realizing the incompleteness of the work described I have yet ventured to report, hoping for opportunity in the near future for fuller investigation.

After the copy for this article was in the printer's hands my attention was called to a paper in the June, 1898, Proceedings of the American Academy of Arts and Sciences (Vol. XXXIII., No. 18) by Henry Crew and Olin H. Basquin on "The Sources of Luminosity in the Electric Arc." They have used the same general method as that employed in preparing this paper, except that their pictures are composites made through a comparatively wide slit, while those here shown are for single exposures through a narrow slit. Their conclusion that the persistent luminosity is chemical or thermal and not electrical would correspond with the work here presented.

Centralized Sources of Energy in Telephone Exchanges—II.

BY KEMPSTER B. MILLER.

In the various systems so far considered the induction coil has played no essential part in the subscribers' station outfits. Many attempts have been made to combine the well-known advantages of the induction coil with those of the centralized source of energy for supplying transmitter current, and the problem has been attacked from several different standpoints. One plan has been to run a separate supply wire through all of the stations for furnishing to them the requisite current, the regular line circuits of the telephone being associated with the supply circuit by means of the induction coil. While this general method has, so far as I am aware, brought about few if any practical results, it has led to some very interesting and ingenious developments, and is therefore worthy of consideration.

Charles E. Scribner, the most prolific of telephone inventors, produced in 1881 a system the principles of which are shown in Fig. 10. In addition to the regular lines *L L* of an ordinary exchange he ran a supply wire *S* serially through all of the stations, this wire including a battery *B* at the central station. At each station the supply wire passed through the arms of a Wheatstone bridge, having three fixed resistance arms, r^1 r^2 r^3, and a variable resistance arm formed by the circuit through the microphone *M*. In place of the galvanometer ordinarily used with a Wheatstone bridge was the primary *p* of the induction coil, the secondary *s* of which was placed in the line wire *L* in series with the receiver *R*. The lines *L* ran to a switchboard at the central office in the ordinary manner. The resistances of the various arms of the bridge were adjusted with respect to each other, so that under ordinary circumstances little or no current flowed through the primary coil *p*. When, however, the resistance of the microphone was varied the balance of the bridge was destroyed, and currents were caused to flow through the primary of the induction coil first in one direction, then in the other, according to whether the resistance of the transmitter was greater or less than its normal value. These currents acted inductively upon the line circuits to produce the desired results.

Another interesting system, devised by Mr. John S. Stone, and adapted primarily for the supply of the operators' transmitter circuits in a central office, is shown in Fig. 11. In this a dynamo *D* was used in a separate supply circuit *S*, which circuit included the microphones *m* of all the stations and also two coils *I I* of high impedance, the latter being for the purpose of smoothing out all fluctuations in the supply circuit as a whole, whether these fluctuations originated in the dynamo or in the transmitters. Three different arrangements of apparatus with respect to the supply circuit are shown in this figure. At station 1 the transmitter is included directly in the line wire and the primary winding of the induction coil shunted around it. At station 2 the transmitter is included serially with the primary coil in the supply wire, the two being shunted by a non-inductive resistance *r*. At station 3 the arrangement is the same with the exception that a condenser *c* is substituted for the non-inductive resistance *r* at station 2.

At station 1 an increase in resistance of the transmitter will divert a greater portion of the current of the dynamo through the primary coil *p*, and a decrease in the resistance will allow a greater portion of the current to flow through the transmitter itself and a corresponding smaller portion through the primary. At station 2 the action is similar save that the current through the primary varies directly as that through the transmitter instead of inversely as in the former case. At station 3 the changes in resistance of the transmitter varies the potential of the charge of the condenser *c*, and therefore causes fluctuations in the current through the primary *p*. The current actually flowing through that coil may be considered as the resultant of the steady current from the dynamo and an alternating current from the condenser superimposed upon it. In any of the three cases the current remains constant in the supply circuit as a whole, while the variations in current set up by the transmitters flow freely through the corresponding local circuit only.

In the arrangement shown in station 1 the primary of the induction coil is preferably wound to a resistance of fifty ohms and the ratio of the number of its turns to that of the secondary is that of two to three. In the arrangement shown in station 2, where the primary coil is in series with the transmitter, the resistance of the primary is as low as five or ten ohms, it being wound, however, with a coarse wire so that it may have a large number of turns and therefore a high coefficient of self-induction. At station 3 where the condenser shunts the primary coil and the transmitter, a capacity of six microfarads has been found to answer well.

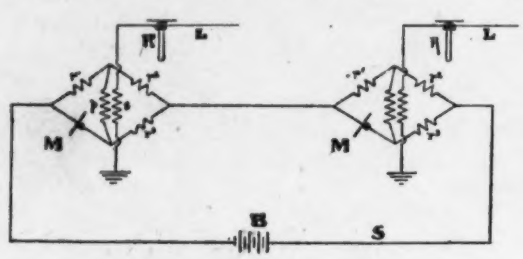


Fig. 10.—Scribner System.

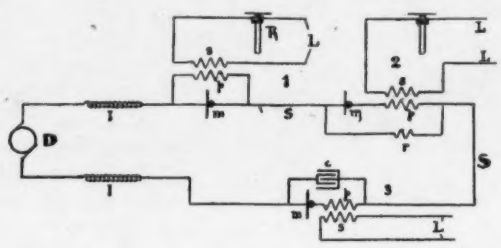


Fig. 11.—Stone System.

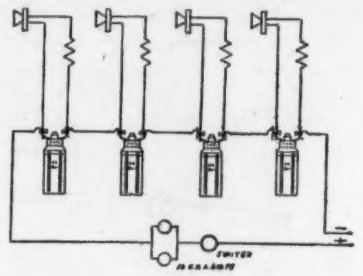


Fig. 12.

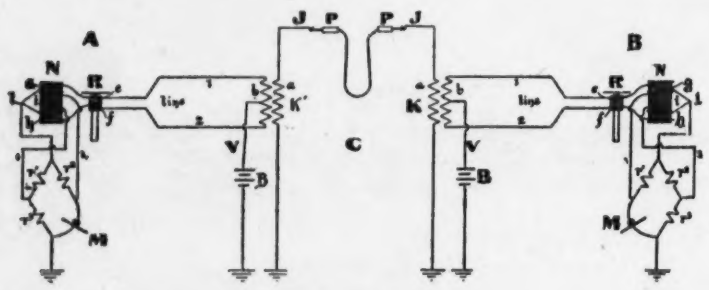


Fig. 14 —Carty System.

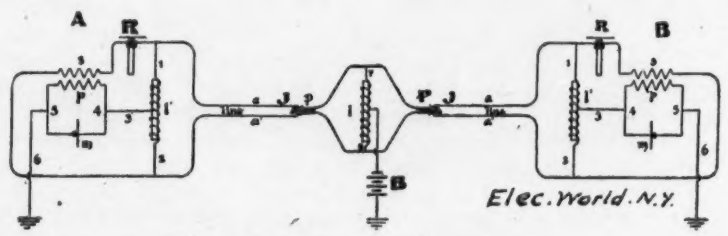


Fig. 15.—Simplified Dean System.

A shunt-wound dynamo having thirty-six commutator bars, running at a speed of 2200 revolutions per minute and generating 12 volts, is described as giving excellent results with this arrangement. The impedance coils *I* were wound to have a joint resistance of 67 ohms and were provided with a soft iron core common to both coils for the purpose of increasing their electromagnetic inertia.

A scheme, which is used to some extent in independent companies for supplying current to the operators' transmitters in central offices, devised by Mr. A. R. Hussey, of Chicago, consists in using a number of storage cells in series in the supply wire, and shunting each cell by the individual transmitter circuits, containing in each case the transmitter and primary of the induction coil, as is shown in Fig. 12. This has the disadvantage of using several small cells instead of a single larger one, but gives excellent results. It is even possible to charge the cells while they are supplying current to the transmitters without producing serious noises in the circuits, and especially is this true if an impedance coil of low actual resistance be placed in the supply wire. The idea shown in Fig. 12 may be given a larger field of usefulness by placing the storage cells at the subscribers' stations, and supplying them with current from a central source. This idea is much older than the particular one here considered and will be described later, as the use of storage cells at the subscribers' stations forms an important branch of the subject treated in the present article.

Mr. W. W. Dean is responsible for a very clever plan of furnishing transmitter current, which may or may not involve the use of a sepa-

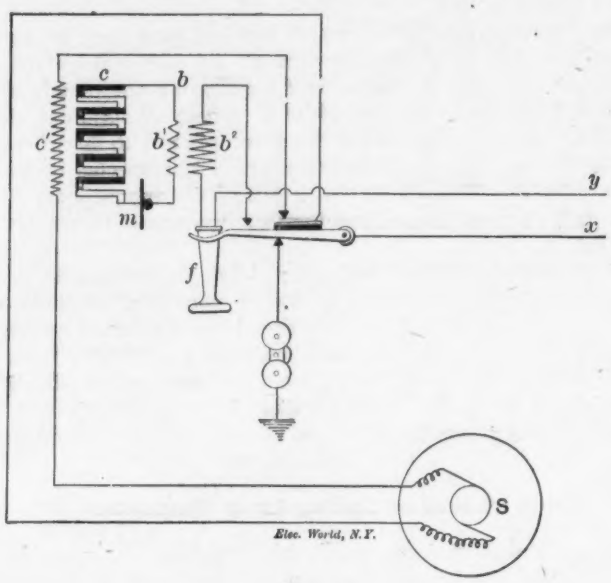


FIG. 13.

rate supply wire. It consists in using a thermal generator at the subscriber's station, and has already been described by me in THE ELECTRICAL WORLD. The simplest apparatus for carrying out this invention is shown in Fig. 13, in which *c* is a thermopile connected in a local circuit containing the microphone *m*, and the primary b^1 of the induction coil. A resistance coil c^1 is wrapped about the alternate junctions of the thermopile, so that when it is traversed by a supply current it will impart heat to the junctions and cause the thermopile to generate a current in the manner well known. The coil *c* may be included in the regular lighting or power circuits of city mains, or it may be supplied with current from a generator *S*, specially provided for that purpose at the central office. The circuit through the coil is normally held open at contacts on the hook switch that are automatically closed by raising the receiver from its support. The receiver *f* and secondary b^2 of the induction coil are included in series in the circuit of the line wires *x* and *y*. The primary circuit is constantly closed, and is associated with the secondary in the usual manner. This idea may develop into something more than a paper invention when the construction of thermopiles has reached a higher state of development and when their adaptability to work of this kind is better appreciated.

Mr. Carty was, I believe, the first to devise a common battery system using the induction coil at subscribers' stations and dispensing with the separate supply wire. This system is the prototype of an entirely distinct class in this branch of telephony and is interesting for that very reason. It is shown in Fig. 14, in which *A* and *B* are the subscribers' stations and *C* the central office switchboard, with its line jacks *J* and connecting plugs *P*. *K K'* are repeating coils, each having its two windings *a* and *b* equal in resistance and in number of turns. The winding *a* of each coil has one of its terminals grounded and the other connected to the spring jack *J* of its particular line. The winding *b* is in each case connected across the two sides 1 and 2 of the metallic circuit, leading to the subscribers' stations. The centre point of the winding *b* is in each case connected by a wire *V* to one terminal of a common battery *B*, the other terminal of which is connected to ground. Two batteries *B* are shown for the sake of clearness, but these would be united in actual practice. The line wires 1 and 2 pass respectively through the equal coils *e* and *f*, on the receiver *R* and the two secondary windings *g* and *h* of the induction coil *N*, after which they unite at the point *l* and pass to ground through a Wheatstone bridge, of which the transmitter *M* forms one branch. The primary coil *i* of the induction coil is placed in the bridge wire 3, as in the case of the Scribner system already described. Current from the battery *B* finds its way in parallel over the two line wires, 1 and 2, through the receiver coils *e* and *f* and the secondary coils *g* and *h* of the induction coil to the point *l*, where it reunites and passes to ground through the balanced resistances of the Wheatstone bridge. As the pairs of coils *e f* and *g h* are each differentially wound with respect to currents passing over the two branches of the line in parallel, this current from the battery *B* produces no magnetic effects on their cores. The two subscribers are shown connected for conversation. If the transmitter *M* at station *A* is operated, the balance of the Wheatstone bridge is destroyed and undulatory currents are caused to flow in the primary coil *i*. These induce in the secondary coils *g* and *h* corresponding undulatory currents which pass in series through the circuit of the line and therefore always in opposite directions through the receiver coils *e* and *f*. The effects of these currents will therefore always be cumulative, and affect the receiver in the ordinary way. Corresponding currents are induced in the plug circuit by means of the repeating coil *K'*, and these currents are in turn repeated into the line circuit of station *B*, and as they pass through the receiver coils *e* and *f* at that station in opposite directions, they affect its diaphragm as usual.

This idea of using the two sides of a metallic circuit in parallel with a ground return for supplying current to the transmitter, and of using the circuit formed by two sides of the line for the secondary currents, has formed the basis of a series of inventions by Mr. W. W. Dean. One of them is shown stripped of all detail in Fig. 15, in which *A* and *B*, two subscribers' stations, are connected at the central office by the pair of plugs *P*. *B* is the transmitter supply battery, one terminal of which is grounded and the other connected with the centre point of the winding of an impedance coil *I*, bridged across the cord circuit. At each subscriber's station is an impedance coil *I'*, bridged across the two sides *a* and *a'* of the line, and having its centre point connected by the wire 3 with one side of the primary circuit, the other side of which is grounded through the wire 6. Current from the battery *B* flows to the centre point of the impedance coil *I* in the cord circuit; thence through the two sides *a* and *a'* of the line in multiple to the centre point of the impedance coil *I* at each sub-station. Here the two parts of the current unite and pass by wire 3 to the point 4 of the primary circuit, where it again divides; one portion passing through the transmitter *m*, and the other through the primary *p*, to the point 5, where it reunites and passes to ground through the wire 6.

The operation is easily understood. Variations in the resistance of the transmitter cause more or less of the supply current to be shunted through the primary *p* of the induction coil, and these varying currents through the primary induce corresponding currents in the secondary *s*, placed directly in the line circuit with the receiver *R*. These currents flow over the metallic circuit formed by the two connecting lines, and are prevented from flowing through bridge wires 1 and 2, 7 and 8, by the retardation coils *I'* and *I* contained therein.

This system is shown in more detail in Fig. 16, which represents the circuits as they would be in actual practice. All of the reference letters and numerals used in the preceding figure designate the same parts in this figure. The impedance coil *I* at the central station has two windings, 7 and 8. One terminal of the coil 7 is connected to the sleeve strand *s*, while one terminal of the coil 8 is similarly connected with the tip strand *t*, the other terminals of these coils are connected together at the point *l* which forms one

terminal of the common battery *B*. In a similar manner the impedance coil *I* at each subscriber's station is provided with two windings, 1 and 2, connected respectively with the two sides of the line circuits, and having their other terminals joined at the point 3. The iron cores of these impedance coils are in the form of flattened rings in order that a complete magnetic circuit may be provided to increase the retardation of the coils as much as possible. The two windings on each coil consist of about 3000 turns of No. 22 silk-covered wire. As a result of this construction, the coils are of very low ohmic resistance, especially when placed in parallel as they are with respect to the battery currents; but they present an extremely high impedance to the voice currents flowing in the metallic circuit formed by the two line wires, for it is evident that in order to pass from one side of the circuit to the other these currents would necessarily pass through the two windings of the impedance coil in series. The currents from the battery *B* passing through the two windings in parallel produce no magnetic effect upon the cores of the impedance coils, and, therefore, these coils are in a condition to offer a maximum amount of retardation. This is due to the fact that a mass of iron when in a neutral magnetic state is more susceptible to a magnetizing force than when the mass is polarized.

At the sub-stations the supply circuit divides and passes through the two halves of the primary circuit in multiple, as in the preceding figure; but in this case two primary coils are provided, one in each side of the primary circuit, so that the changes in each side of the circuit may be utilized in producing an inductive effect upon the

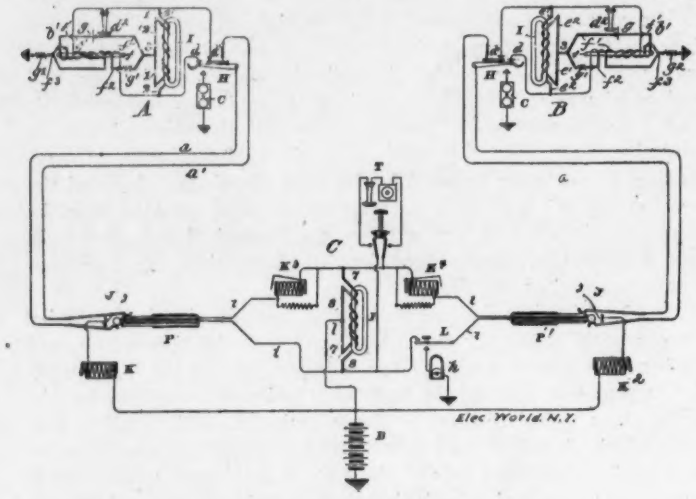


Fig. 16.—Dean System.

secondary coil. Thus at station *A* the circuit divides at the point 3, one-half of the primary circuit being indicated by the heavy black line *f'*, and the other half by the double line f^2. The wire *f'* includes the microphone *g*, and then passes around the core *f* of the induction coil to the point f^3. The other wire, f^2 passes from the point 3 through the coil *g'*, and thence around the core *f* to the point f^3, where the wires unite and pass to ground through a resistance g^2. The coil *g'* is intended to have about the same resistance as that of the transmitter when in its normal state, so that the supply current will divide equally between the two sides of the transmitter circuit and therefore normally produce no magnetization in the core. A decrease in resistance, due to the microphone, will cause a greater current to flow through the wire *f'* and a less current to flow through the wire f^2, and these changes will serve to induce a current in the secondary coil *s* in circuit with the line wire and the receiver *R*. An increase in the resistance of the microphone will act in the reverse manner, and induce a current in the opposite direction in the line circuit.

The limbs *a* and *a'* of each line terminate in contacts on the hook switch *H*, and when the hook is raised complete the connection from these line wires through the telephone apparatus at the sub-station. When the hook is depressed by the weight of the receiver the limb *a'* of the line is left open at the contact *d'* on the hook, while the limb *a* is connected to ground through the high wound polarized bell *C*.

The circuits at the central office are illustrated with sufficient clearness to need no explanation further than to state that *K'* and K^3 are line annunciators, and K^2 and K^4 are clearing-out annunciators, the latter being connected in series in the sleeve strand of a pair of plugs, *P* and *P'*. In order to follow the operation of the system, assume that subscriber *A* desires a connection with subscriber *B;* he removes his receiver from the hook, thereby disconnecting his high-wound bell *C* and connecting the two sides of the line with the two terminals of his station apparatus. A current from the battery *B* is thus allowed to flow through the drop *K'* to the two sides of the line in multiple, by virtue of the fact that the tip and sleeve springs of the jack rest upon the common anvil *j*. The current flows through the two sides of the subscriber's circuit in multiple, and to ground, and is of sufficient strength to cause the annunciator *K'* to raise its target. The operator seeing the signal inserts the answering plug *P*, thus cutting off the circuit through the annunciator *K'* and allowing its target to assume its normal position.

The circuits are now completed from the battery *B*, through the two halves of the impedance coil, and to ground at the subscriber's station, as already described. The operator then bridges her telephone set *T* across the cord circuit by means of the key provided for that purpose, and communicates with the subscriber. Learning that subscriber *B* is wanted, she inserts the calling plug *P'* into the jack of his line and depresses the key *L*, which connects one terminal of the grounded generator *h* with the tip strand of the cord, and, therefore, with the side *a* of the line. A current flows from the generator to ground at the subscriber's station, and operates the polarized bell *C*. That subscriber then removes his receiver from the hook, and the two converse over the metallic circuit formed by the two connected lines.

While the subscribers' receivers are removed from their hooks the current from battery *B* flowing through the sleeve strand of the cord circuit energizes the magnets of the clearing-out annunciators, K^3 and K^4, and causes them to lift their targets. As soon as either subscriber hangs up his receiver this current ceases to flow, because the line wire *a'* with which the sleeve strand is connected is opened at the point *d'*. This allows the target of the annunciator, K^3 or K^4, to fall, showing that that subscriber has ceased to use his instrument.

This represents perhaps the highest development attained in any of the methods for centralizing all energy sources of telephone systems so far described, and has therefore been considered somewhat in detail. Both calling and talking currents are supplied from the central office, the apparatus at the sub-stations are greatly simplified, all signals on the part of the subscribers are automatically sent, and all switchboard drops, both line and clearing-out, are self-restoring.

(To be continued.)

A Method of Coating Lamp Filaments.

Patent No. 616,276, issued to O. M. Thowless, December 20, describes a method of coating carbon filaments with oxides of high emissivity and avoiding the difficulty usually found through the difference between the coefficients of expansion of carbon and such oxides. The carbon base of the filament is covered with a tube of fibrous, combustible material, such as cotton, which may be impregnated with the salts of one or more suitable metals, such as thorium, zirconium, yttrium or lanthanum, the cotton being afterward taken off, leaving a loosely fitting cover of metallic oxide. The carbon may either be threaded through the tube of fibrous material, or the latter may be woven around the carbon, and the metallic salts may be applied either before or after the carbon has been inserted. The patent states that "a lamp thus made is found to be durable and efficient, and the light-giving properties of the filament are materially enhanced by the presence of the coating. The coating adheres more or less closely to the surface of the filament, and this intimate relation of the metallic oxide with the filament secures stability for the entire structure. This method of applying the coating permits the necessary expansion and contraction of the filament without causing the coating to be broken."

Wanted: More Insurance, Less Assurance.

A peculiar accident due to the collection of static charge by belt friction occurred recently in the works of the Warder, Bushnell & Glessner Company, at Springfield, Ohio. While one of the employees was cleaning his hands with naphtha the belt on his machine shifted toward the tight pulley, causing him to raise his hand to the shifter to move it back. A static spark jumped to his hand, igniting the naphtha and burning him severely.

Telegraphing Without Line Wires*—I.

BY WILLIAM BISSING.

It will be seen from the patents hereinafter cited that the present subject is not new. It has occupied the attention of inventors for at least fifty years; and, indeed, if we include signaling by flashlight or by sound, it will be found that for thousands of years man has been endeavoring to communicate to distant points without the intervention of artificial connecting media. It would, however, go beyond the limits of this article to mention all the experiments and applications of the various forms of signaling by light and other natural agents that have been tried for so many years. In view of the renewed interest in the subject that has been aroused by recent experiments of English and Continental physicists, who have used electrical methods for accomplishing the above result, and in view of the close relationship which exists in this country between the work of the theoretical scientist and the work of the practical inventor, it may be of interest to give a review of the electrical development of the patented art bearing on this form of signaling.

The electrical methods which have been used to transmit intelligence without intervening wires may be broadly divided into three distinct classes, i. e., conduction methods, in which battery currents are used and in which the earth serves as a conductor; methods in which the transmission is effected by induction, and electrical wave methods. Induction methods may be again subdivided into two classes, to wit: Electromagnetic and electrostatic methods.

CONDUCTION METHODS.

About the earliest patent in which the earth is used as a conductor to effect transmission is the English patent to Lindsay, No. 1242, of 1854. This patent contains all the essentials which enter into this means of telegraphing, and is open to all the objections that accompany this system. In it, as shown in Fig. 1, the patentee telegraphs across an intervening water course by using on one side of the water a battery, *B*, connected to two plates which are placed a considerable distance apart in the stream or lake. On the opposite side of the water course are placed two corresponding plates connected by wires which include a galvanometer and another battery. The patentee states that "the distance between the two plates on one side of the water course is greater than the distance across the water or to the plates of the opposite battery. Suitable keys, *K*, may be placed in the circuits. On closing the key in one circuit the electric current will pass into the water at *C*, through the wire or wires which are on the opposite side of the water, and re-cross at *F;* or, more correctly speaking, the electric current divides between the two courses in an inverse ratio to their resistances, so that a portion of it takes the circuitous course." It will, of course, be evident that the distance between the plates of one circuit may be diminished, if at the same time the e. m. f. of the battery connected to these plates be increased.

In the conduction system we are dealing with two plates buried in a conducting medium and kept at a suitable difference of potential. We may imagine the current distributed through the medium along certain stream lines, a fall of potential resulting along the different lines of flow. If the two ends of a receiving circuit be grounded at two points between which there is a sufficient difference of potential, enough current will be shunted through this circuit to actuate a recorder. An analogous case is afforded by the laboratory experiment, in which the lines of flow of the current from a battery are determined, when its poles are placed in contact with a sheet of tin foil. One end of a circuit which includes a galvanometer and a battery is touched to the sheet of foil, and the other end moved until a position is found for which the galvanometer gives no deflection. The former end of the circuit is then kept in its original fixed position on the tin foil, and the latter end moved until another point is found for which the galvanometer deflection is zero and so on. These points are then plotted and enough pairs of points found to locate the equipotential curves, which are normal to the lines of flow. It will be seen therefore that in the conduction system, the receiver might have its terminals so located that no current from the transmitter will be shunted through it and that the best position for the terminals of the receiving circuit is in a stream line of maximum intensity and at right angles to the equipotential curves. It will also be desirable to curve the end plates of the receiving circuit to fit the equipotential curves at the points where they are buried in the earth so that all the points of each plate may be at the same potential. This will avoid local circuits in the plates. Usually such curvature will be unnecessary, since the plates are small and the stream lines are straight at the points where the receiving terminals are located, and plane plates may consequently be substituted.

The objections to this method of transmission are many and obvious. Nowadays, when, in all large cities, currents from railway circuits and lighting systems are constantly leaking to earth, great disturbances of the instruments used in this system must be expected. Secrecy is impossible, since anyone may ground his instrument, and thus receive the signals intended for another. Only a small portion of the current generated by the battery will pass through the receiving instrument. This instrument must, therefore, be quite sensitive, which in turn may render it subject to the disturbances above referred to. The battery current, moreover, is short circuited by street-car rails, gas pipes and water pipes, so that very little current will reach the recorder.

It is interesting to notice, however, that this particular method has been many times revived, even as late as 1894, when it appeared in "Cosmos," Paris, March 3, 1894, republished by the "Electrical Review," Vol. 24, p. 193, which described some experiments by the Abbé L. Michel, in which telephones were used as receiving

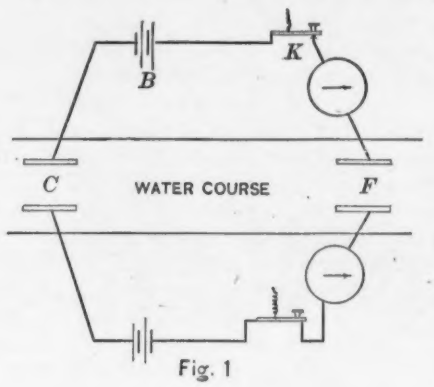


Fig. 1

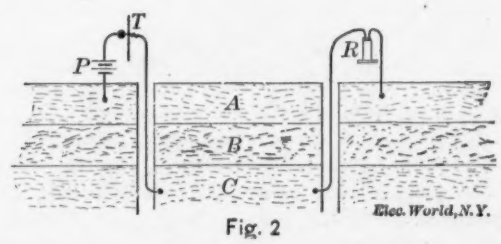


Fig. 2

and transmitting instruments. See Fig. 2. Five accumulators *P* were used in the transmitter circuit, and with the receiver *R* placed in a building about 3000 feet away, telegraphic dispatches were heard quite distinctly. In these experiments two distinct paths may be arranged for the electric current, according to the position of the plates in each circuit. If a plate is placed at the bottom of a well at *C*, and the other plate of the same circuit is placed in the surface soil *A*, and if there is an intervening layer *B* of high resistance soil between the transmitter plates, the plates of the receiving instrument *R* being similarly located, then the path of the current will be from one plate of the transmitter through the surface soil to the corresponding plate of the receiver, then through the receiving instrument and back by the bottom layer of earth. The intervening high resistance stratum will prevent short circuiting of each instrument. The other method would be to locate the plates of each instrument a suitable distance apart, but all of them in the surface soil, which is substantially the method of the English patent to Lindsay.

Between the dates of Lindsay's invention and the "Cosmos" article a number of patents have been taken out, all based on the principle of the resistances of branched circuits. Among them may be enumerated the following: In Great Britain—Haworth, No. 843, of 1862, and No. 2682, of 1863; Smith, No. 8159, of 1887;

*The classification adopted in this article has been followed by the patented art in its development, and is also that which has been used by Prof. S. P. Thompson in a review of the literature of the subject in the "Journal of the Society of Arts," London, April 1, 1898.

Stevenson, No. 5498, of 1892; Smith et al., No. 10,706, of 1892; and in the United States the following: Ader, No. 377,879, February 14, 1888; Blake, No. 526,609, September 25, 1894.

The Smith patents show a means of communicating from the shore to a lighthouse on an island by the use of submerged plates, one pair being connected to a receiving instrument in the lighthouse, and another pair arranged to include the former pair between them, the latter pair being connected by wires to a transmitting battery and key on the shore. In the last cited patent to Smith step-down transformers are used to energize the plates located in the signaling circuit. These, of course, generate heavy currents, so that an appreciable part of them may flow through the receiving instrument in the lighthouse. It is evident that devices of the last-named character can transmit signals through a short distance only without intervening wires. The advantages that result from their use are due to the ability of dispensing with shore connections for the cables on rocky coasts where lighthouses are usually situated. In heavy gales the ordinary cable is often torn from its bed and communication between the shore and the lighthouse is interrupted. By burying one of the plates of a conduction system in the ocean sufficiently below the surface of the water to avoid the disturbing action of the waves on the signals, and its neighbor in a well on the lighthouse shore, the necessity of bringing a cable end on land is avoided, and a fairly satisfactory means of communication is established.

An application of this method to ship signaling seems to offer a chance of success, owing to the short distance between the ship and the signal transmitting circuit. In this connection the following patents may be cited, which illustrate a means of avoiding collisions of ships with each other, or of preventing them from running ashore: In Germany, Somzee, No. 44,101, of 1888; in Great Britain, Stevenson, No. 5498, of 1892, and in the United States, Blake, No. 526,609, September 25, 1894.

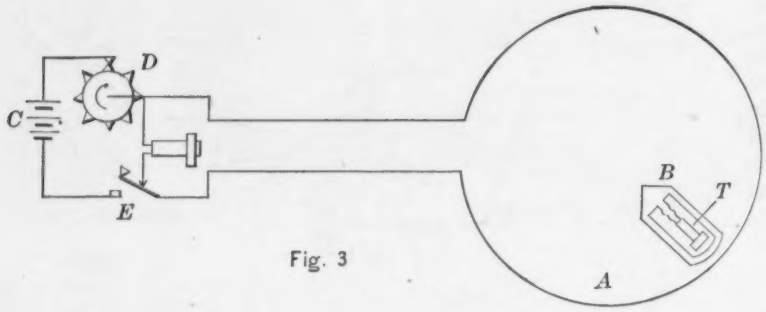


Fig. 3

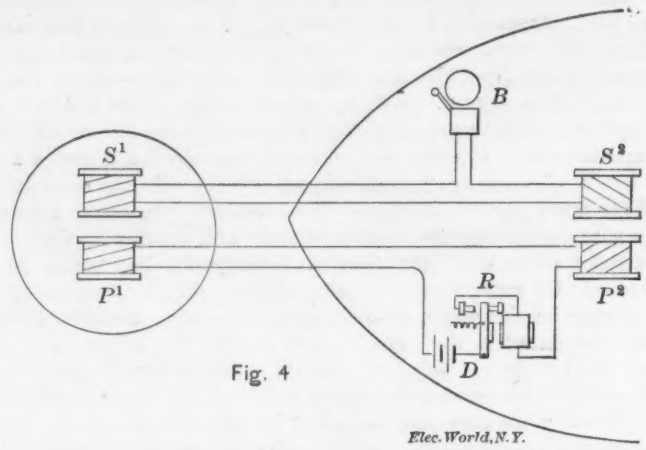


Fig. 4

Elec. World, N.Y.

In Somzee's invention each ship carries a pair of plates submerged in the water, one at the bow, the other at the stern, the plates being connected by wires which include a signal-receiving instrument, such as a telephone or galvanometer. Shoals may be indicated by suitably energized stationary plates, the current from which is diverted into the receiving circuit on the ship whenever the vessel approaches shallow water. A similar method is used in the Stevenson and Blake patents. The conduction system of transmission is fully explained by Rathenau in a report to the General Electric Society in the "Elektrotechnische Zeitschrift," for November 8, 1894, in which it was suggested that a telephone receiver be used to receive the signals. The metallic diaphragm of the telephone was to be replaced by a light tongue, which should be tuned to respond to the predetermined rate of vibration of the transmitting circuit. This rate was to be imposed upon the circuit by a suitable tuning fork operating a circuit breaker. The investigator stated that communication had been effected over a distance of 3 miles.

INDUCTION METHODS.

These methods have already been classified into electromagnetic and electrostatic systems. The difference between them is largely one of degree, inasmuch as in each both kinds of induction may play a part, although usually the effect of one preponderates over that of the other. The intimate relationship which exists between the two methods is explained by the modern theories of inductive action. Maxwell's theory assumes that an e. m. f. which acts upon a dielectric produces an electric displacement, and that the change in electric displacement is an electric current called the displacement current. This displacement current in dielectrics is accompanied by magnetic force. It originates a field of magnetic lines of induction which surround it just as a wire carrying a current is surrounded by lines of force. The converse propositions whereby displacement currents are created by the change in the intensity of a magnetic field readily follow from the original assumption.

According to the J. J. Thomson theory, both kinds of induction are produced by electrostatic tubes of force, called by him Faraday tubes, some of them open and some closed, which are distributed through the ether. Each open tube which starts from a positive charge of electricity terminates on an equal and opposite negative charge. This gives rise to the ordinary phenomenon of electrostatic induction. The phenomena of the electromagnetic field are due to the motion of the Faraday tubes, or to changes in their position or shape; if, for example, a moving tube cuts a closed conductor, a current is induced in it.

The differences in the two methods above referred to result from the relative importance of the induction coil and the condenser in the particular circuit under consideration. In electromagnetic induction methods the magnetic field of the circuit supplied by the induction coil is the important element, in the so-called electrostatic system the effects are due to the condenser which gives rise to the electrostatic field of force.

The term electrostatic induction, which has been freely used, seems to be a misnomer when applied to phenomena which are due to electricity in motion. The appearance and disappearance of the induction tubes which accompany the charge and discharge of a condenser give rise to the induced current, and the effect is not one of electrostatics but of electrokinetics. It would be more accurate, therefore, to apply the term capacity or condenser methods to the class called electrostatic induction, and the phrase mutual-induction system to the electromagnetic-induction methods. The older terms have been retained for convenience.

ELECTROMAGNETIC INDUCTION METHODS.

About 1893 Mr. W. H. Preece gave a renewed impetus to the electromagnetic induction class by some experiments performed in England, in which the inductive method was exhaustively tried. In previous experiments by the same investigator in which buried plates were connected to two parallel wires a considerable distance apart, the effects were attributed largely to earth conduction, and it was necessary to prove that the action in the later trials was electromagnetic in its nature. This was unquestionably true in some of the experiments, but there is still some doubt as to the nature of the action in all the tests. One method was to use insulated copper wires in quarter-mile squares laid on a level plain, a quarter of a mile apart. Alternating currents were sent through the transmitting circuit, and these, when interrupted by means of a telegraph key, gave Morse signals which were received in suitable telephones. The data are given in full in the Proceedings of the Electrical Congress at the World's Fair for 1893, published by the American Institute of Electrical Engineers.

The electromagnetic induction method has been the subject of a number of patents, attention being called to the following: In the United States—Phelps, No.307,984, Nov. 11, 1884; 312,506, Feb. 17, 1885; Woods, No. 373,915, Nov. 29, 1887; Ader, No. 377,879, Feb.

14, 1888. In England—Evershed, No. 10,161, of 1892; Sennett, No. 13,415, of 1892, and Evershed, No. 18,312, of 1896. In Germany the patent to Somzee above cited.

The patents to Phelps and to Woods furnish applications of the method of transmitting signals to or from a moving railway train. A coil of wire, including in its circuit a transmitting key and a receiving instrument, is located on the car so that the coil may pass in close proximity to a telegraph wire strung upon poles or on the roadbed. These devices necessitate the presence of a telegraph operator upon the car, and inasmuch as it is an easy matter to dispatch telegrams at the nearest stopping point which may be written out on the train, it will readily be seen why this system has not gone into extensive use.

The English patents to Evershed and to Sennett above cited disclose methods of signaling from the shore to lightships or other vessels approaching the shore. An inductive circuit is arranged with a coil A, see Fig. 3, located in the ocean in a horizontal plane, the coil being supported, if desired, by suitable buoys so as to bring the magnetic field produced by the coil near the surface of the water below the vessel B which sails over it. The signaling circuit may be produced by an alternating-current dynamo, or by means of a battery C and revolving contact wheel D, which rapidly interrupts the battery current. A telegraph key E is used, by means of which signals of short and long duration are given according to the Morse or other code. The receiving instrument may be a telephone receiver T or an electromagnet acting on a reed of metal tuned to correspond in pitch to the frequency of the secondary currents. A call bell may be rung by means of a local battery in the circuit of a relay, the relay consisting of a tuning fork designed to respond to the timed impulses of the transmitting circuit.

In the German patent to Somzee, which has been discussed above, a modification is used which adopts the principle of the Hughes induction balance. See Fig. 4. In this method the balance is formed by two circuits, each including a pair of coils, one circuit being completed through a battery D, and automatic circuit breaker R, and the other through a bell. One pair of coils $P^2 S^2$ is placed upon the ship, the other pair $P^1 S^1$ is located upon a float which is dragged by the ship. The inductive effect of P^2 on S^2 is normally balanced by that of P^1 on S^1. When the vessel approaches a shoal, which should be marked by means of a large metal buoy, the balance of the currents is destroyed by the metal of the buoy and the bell rings. The method employed by Somzee has been used by Huskisson in patent No. 542,732, July 16, 1895, for the automatic firing of mines located in a harbor. The induction balance is connected to the mine, and when the ship passes over it the current balance being destroyed by the inductive action of the metal of the ship, the mine is fired.

In the methods which have just been described the effects are due to mutual induction. The current flowing through the signaling circuit creates a magnetic field of force, the lines of which penetrate the receiving circuit. Any change in the intensity of the current produces a corresponding change of the field, and this gives rise to an induced current in the receiving circuit, whose e. m. f. is measured by the rate of decrease of magnetic induction through it. This gives the equation

$$E = - M \frac{di}{dt}$$

in which E is the induced e. m. f. at any instant, M is the coefficient of mutual induction of the two circuits, and i is the current in the inducing circuit at any instant.

If, as in some of the cases discussed above, we have an alternate current flowing through the primary circuit whose equation is

$$i = I \sin a$$

in which I is the maximum value of the primary current, we have for the value of the induced e. m. f.:

$$E = M I \cos a \frac{da}{dt}$$

The effective secondary induced e. m. f. is therefore:

$$E' = 2 \pi f M I'$$

in which I' is the effective primary current, f is the frequency of the primary current wave, and M is the coefficient of mutual induction.

It follows from this equation that in order to make this method of signaling as sensitive as possible we must use large currents of high frequency in the signaling circuit, as many turns of wire as possible in both circuits and increase the permeability of the intervening medium by introducing magnetic materials therein.

(To be Continued.)

The Penetration of Beams of Light.

BY BUCKNER SPEED.

As a ship moves away from a beacon light it is noticeable that the apparent intensity of the light becomes less brilliant as the distance increases. It would be naturally supposed that this diminution would follow the law of inverse squares. Such, however, is not the case, nor is the rate of diminution even a smooth curve. It has been frequently noted that the brilliancy of the light decreases rapidly in the early part of the time of departing from the light, more rapidly than the second power, in fact; but when a certain distance and brilliancy of appearance are reached the brightness of the light remains constant for a long distance of increased departure, this flat place in the curve of decreasing brightness again breaking off into a rapid fall and final extinction of the light due to distance and opacity of the atmosphere.

This maintained equality of a distant light which the observer is leaving is well known to light-house authorities, and the following is quoted from a former member of the United States Light-House Board: "As a person retires from a light its apparent intensity diminishes for a certain distance; beyond this, the light appears to be steady for a very long space. The point at which the reduction ceases is called the limit of punctual vision."

The explanation for this curious phenomenon, which has suggested itself to the writer, is that during the first rapid decrease of brilliancy the iris of the eye is contracted as far as its structure will allow, and the eye is receiving light on the retina in proportion to the brilliancy of the light. As the distance from the light increases the light continues to lose in brightness until the iris is not so severely tried and begins to open. Then the opening of the iris to a certain extent compensates for the diminishing of the light by admitting an increased volume.

When the iris has opened to its fullest extent the compensation ceases, and the aperture of the eye remaining constant, the light is seen to rapidly diminish, following the law of squares and aided also by the opacity of the atmosphere.

If the case of the actual (not physiological) rate of diminution of the light is considered, under the ordinary condition of not perfectly transparent air, a set of interesting modifications, of the text-book law—that the intensity of light varies inversely as the square of the distance from the light—are found to follow.

Take, for example, a perfectly collimated, that is parallel, beam of light. Were the air perfectly clear and homogeneous, the intensity of the beam would be undiminished by distance.

Let the beam, however, be shining through atmosphere which will diminish its brightness q per cent. in unit distance, or what is the same thing, will allow p per cent. to pass through unit distance. If at the reference point the intensity of the beam is I and the permeability of the air is p per cent., then the intensity i, at distance x, will be

$$i = I p^x \text{ or}$$
$$\log i = \log I + x \log p.$$

And if the light emanates from a small point and its intensity at unit distance is I, the expression becomes

$$i = \frac{I p^x}{x^2} \text{ or}$$

$$\log i = \log I + x \log p - 2 \log x.$$

Further, in the case of a searchlight in which the angular divergence of the beam is between 2° 30′ and 3° and the beam is a truncated cone, with the smaller end starting at the mirror of the reflector, let the angle of divergence of the beam be a, then the distance behind the mirror to the virtual apex of the cone prolonged will be

$$f = \frac{d}{2 \sin \frac{1}{2} a},$$

d being the diameter of the mirror measured in the same units as f, and

$$i = \frac{f}{(f+x)^2} I p^x.$$

These formulæ will hold true for conditions of homogeneous permeability as for a horizontal beam on a still night when there are no broken strata of fogs.

On the other hand, if p vary, and can be made to be $p = f(x)$, i. e., a function of x

$$i = I \int f(x) \, dx$$

and the other above equation will take the same form involving an integration to reach the factor p.

The Automatic Compounding of Alternating Dynamos.

In a paper recently presented before La Société Internationale des Electriciens, by M. Maurice Leblanc, there is described a very ingenious system of compounding alternators, resembling closely the design described in United States patent No. 595,412, issued to E. W. Rice, Jr.*

It is hardly necessary to repeat the reasons for the need of such a system. Machines built for close regulation with constant field current have necessarily an output greatly reduced below that determined by the heating limit and consequently a greater cost and iron loss per kilowatt output, and even then do not give the regulation desired. The exciter described by M. Leblanc is illustrated in Figs. 1 and 2. It consists of a machine resembling a rotary converter in that it has a commutator and collecting rings, but provided with two distinct armature cores and field yokes and three separate windings. In the machine shown these windings are of the gramme-ring type. The coils S_1, wound upon the core A, revolving under the poles of the field magnet D, are grouped in the same phase relation as those of the main machine and are connected up through the collector rings in such a way as to receive alternating current proportional to the external load of the main machine. The windings S_2, on the core B, revolving between the poles of the field magnets E, are connected through the collector rings in such a way as to receive alternating currents proportional to the voltage of the main machine which the exciter serves. In other words, the latter coils are in shunt with the armature windings of the alternator, while coils S_1 are in series therewith. The exciter windings may be and preferably are supplied by transformers, of the constant-potential type for coils S_2 and of the series type for coils S_1. The means of supplying the shunt and series coils of the exciter of a three-phase machine through six collector rings, as shown in Fig. 1, are illustrated diagrammatically in Fig. 3. The coils S_1 and S_2 are both Y connected with a neutral point common to both Ys. Over both cores A and B (Fig. 1) there is mounted a third winding suited for the generation of direct current and connected to the commutator C.

The exciter is designed to be run at such a speed that the alternations induced in the windings of its armature are synchronous with those of the main machine; in other words, the rotating fields induced by the currents in windings S_1 and S_2 remain stationary in space, their only action being to react upon and distort the field magetization. Field exciting coils are shown, but these are only used in starting the machine as a direct-current motor and bringing it up to synchronism, after which they are left on open circuit There is also shown a short-circuited "squirrel cage" *eeee* in the pole pieces, for use in exciting single-phase alternators, its function being to give a true rotating field with respect to the armature coils from the fluctuating field of the single-phase supply, as does the short-circuited winding of a single-phase induction motor. The cross section of iron and number of turns are so chosen that at the

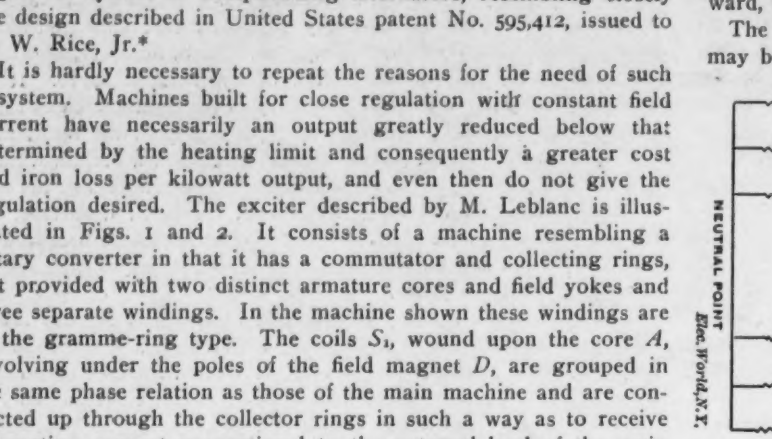


Fig. 1.

normal voltage of the main machine, the magnetic circuit B E is over-saturated, while the magnetic circuit A D—the excitation of which is proportional to the load of the alternator—remains below saturation at full load. The rotating field in core A, induced by coils S_1 is at any instant displaced in space from the field induced by coils S_2 by an angle proportional to the ratio of the self-induction of the armature windings of the alternator to their resistance. Considering the direction in which the armature revolves as forward, the field of B leads that of A.

The exciter, if of the same number of poles as the main machine, may be directly coupled to it, or, if of a smaller number of poles,

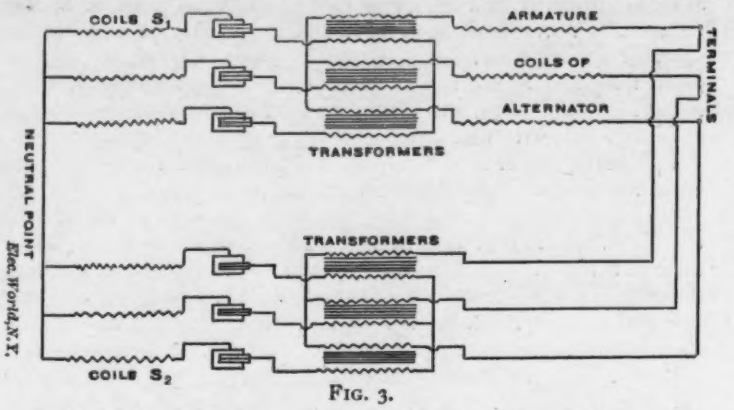


Fig. 3.

may be driven through gearing with a speed ratio designed to keep the two in synchronism. A better method than either is to allow the exciter to run itself by the synchronous-motor action of the rotating field induced in B, on the poles of E, the windings S_2 inducing a magnetic flux in the poles E by the reaction of wattless currents. The machine will then generate a direct-current e. m. f. across the brushes on commutator C which will be proportional to the field flux set up in the two magnetic circuits, in turn dependent on the armature reactions of coils S_1 and S_2. It can be shown that under these circumstances the direct-current voltage delivered and consequently the current in the field windings of the main alternator, which are supplied therefrom, can be made to vary in such a way as to neutralize not only the armature reaction of the main machine but the ohmic and inductive drop in the armature coils thereof, thus automatically delivering constant potential at the terminals This is proven mathematically in the original paper, an untechnical explanation of the action being as follows: The currents in coils S_1 are proportional to the external load of the alternator, and as the iron of their magnetic circuit is maintained below saturation, set up an armature reaction and consequently a reactive field excitation proportional thereto. In case the load of the main machine becomes inductive, thus tending to demagnetize its field magnets, the field exciting action of coils S_1 shifts in space toward that of coils S_2, thus tending to further build up the flux in field ring D and with it the direct-current exciting voltage.

Experimental verification is also described in the same paper, the work having been done in the shops at Saint-Ouen of La Société Anonyme pour la Transmission de la Force par l'Electricité. The

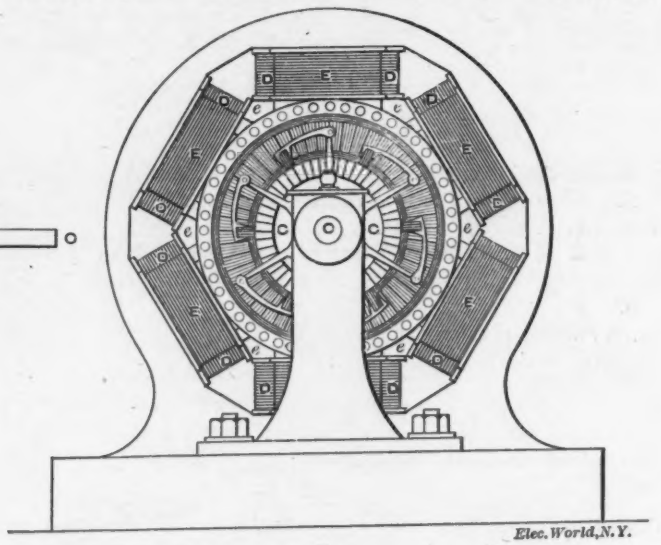


Fig. 2.

main alternator was a 2-phase, 6-pole, 40-cycle, 110-volt machine rated at 60 kilowatts. The exciter was made of the same number of poles and mounted on the main shaft. The alternator was of a very peculiar design for a generator, being built with an internally revolving field, not pole wound, but consisting of a toothed ring

See The Electrical World, February 12, 1898, page 219.

wound with three groups of coils connected between three collector rings intended to be short-circuited to run the machine when desired as an induction motor. The arrangement of the armature and field iron, the slots and the overhanging teeth are shown in Fig. 4. To use the machine as a generator a direct current was introduced between two of the collector rings, thus passing through one-third of the field coils, the windings being delta-connected. The armature reaction of this machine was naturally extremely high, the field

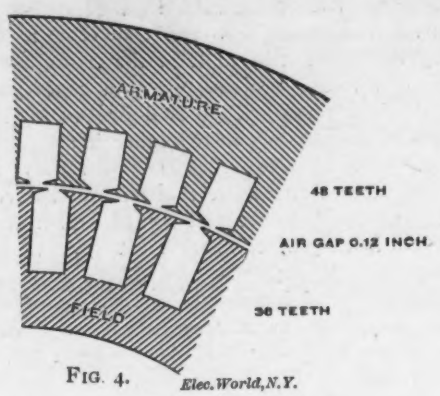
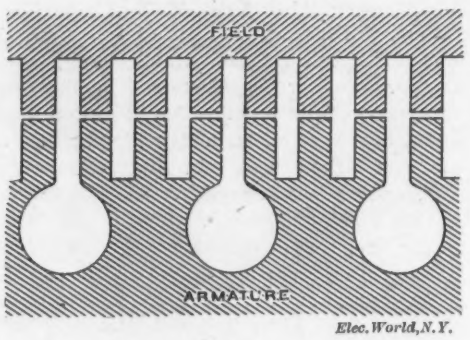


FIG. 4. *Elec. World, N.Y.*

requiring over three times as powerful an exciting force to give the rated armature current on short circuit as it did to give the rated voltage with the armature open-circuited.

The arrangement of the slots and teeth of the exciter armature is shown in Fig. 5. Circular tunnels contained the windings through which passed the coils for the alternating currents, the parallel-sided slots containing the direct-current windings. The field pole, as shown, is also fitted with a winding in slots intended to balance out the distortion of the direct currents in the armature, but this was not found necessary, and in case of a rotary converter action would naturally never be found necessary, as rotary converters have no armature distortion. With a constant demagnetizing current in each phase equal to about 30 per cent. of the rated load current per phase and with a load varying from nothing to nearly full load, with no manipulation of the exciting apparatus, the machine showed an over-compounding action which was truly surprising, considering the belt slip and extreme armature reaction due to the design. The machine was connected in multiple with a 250-kw two-phase alternator direct-coupled to a single-cylinder engine running at only 67 r. p. m. The smaller machine showed its ability to maintain a constant potential, even with great variations of the excitation of the larger, the smaller automatically supplying magnetizing current to the other, and steam could be cut off from the engine supplying either, the smaller machine driving the larger as a motor or vice versa, without other disturbance than the slipping of the belt in the case when the smaller engine was called upon to drive the larger. By exciting a machine in this manner it was found to be possible to increase the number of effective ampere turns per unit



Elec. World, N.Y.

FIG. 5.

area of surface of iron exposed to the air gap to three times as many as could be allowed in commercial alternators built for close regulation and excited in the ordinary manner. The intensity of the field across the air gap of the automatically regulated machine was the same as in the other, and it took no more energy to produce it, as the gap was easily reduced to three millimetres, the wide gap usually required for good regulation not being necessary and the magnetizing force being usefully expended in overcoming the armature reaction instead of wasted in forcing the flux across the gap.

The Education of Electrical Apprentices and Journeymen.*

BY ARTHUR A. HAMERSCHLAG.

Should another generation find an increase in the demands for electrical products and operations comparable with that of the last (and the prospects are good for such an increase), shall we be equally fortunate in finding the skilled men necessary? Is it just as certain these men will be found? The birth of an industry is not the most potent factor in determining its development; it needs the nourishment and care of those engaged in it to make it grow to maturity. With its growth it must develop and nurture the individuals upon whom it most depends. Merit alone will not enable it to be perpetuated and put upon a successful basis which means success unless it is capable of placing its raw material in the hands of skilled workers, upon whom absolute dependence can be placed. It is to accomplish this most essential factor of future success that I believe it time that we give a thought to meeting the coming demand by educating the apprentices and journeymen to that point which will make it possible for our boldest conceptions in electrotechnics to be skillfully and economically solved.

As we draw near to the closing days of the century, a hundred years pregnant with progress and events, none is more notable in the world of science than electrical achievements. A thought and a backward glance will show American supremacy in this field. In order, however, to retain this supremacy we cannot afford to rest content with the laurels we have won, else they will be wrested from us.

The Old World has given us excellent mechanics through its apprenticeship system; unfortunately, even in those countries, that system is dying out. This country has never had a well-developed apprenticeship system, and to-day it has almost entirely disappeared, because of the peculiar restrictions placed thereon by the unions and associations and the centralization of work under single financial heads. In fact to-day the apprenticeship system is almost impossible for financial and other reasons, so we must devise some other means of educating the youth who wishes to enter the electrical field.

It is true that three or four of the largest electrical concerns do apprentice young men, but the number is comparatively small, and it requires considerable influence to secure such indentures. The number of applicants is out of all proportion to the number that can be accommodated, and such openings are almost entirely out of the reach of the vast majority, because of isolated locations.

Electrical work as a trade and as a profession is now undergoing the same trials and tribulations regarding the educational means that other trades and professions have undergone in the past, except that the problem in the electrical industry, owing to its rapid growth, is of vastly greater urgency. Because of this growth along scientific and mechanical lines improvements succeed improvements so rapidly that what was considered good practice yesterday becomes obsolete and defective to-morrow. The men or mechanics, who, but a few years ago, handled cleats and mouldings in wiring, are to-day asked to use iron pipe and conduit, requiring totally different tools, materials and methods. And where do these men acquire the efficiency and facility for this work? They acquire it in the crudest and most uneconomical method possible, by experimentally using their employer's material and at his expense in the time during which he is compelled to pay for skilled labor. These improvements certainly result in the loss of journeymen's efficiency, and result in "rule of thumb" mechanics.

This type of mechanic is to be found in all trades, and sometimes he is exceptionally skilled in his work, and thus causes a tendency on the part of employers to desire more men like him, especially when he is placed side by side with the so-called theoretical mechanic who lacks the skill. The falacy of this reasoning is at once apparent when the "rule of thumb" mechanic comes in competition with the well-grounded and educated mechanic who possesses an equal amount of skill. Then the efficiency of the latter is so much greater that there can be no comparison.

Oftentimes we meet men with such a vast preponderance of theoretical training that it has removed the inherent practical skill, and this type of journeyman is almost useless, when judged from the working standpoint. This latter condition is not a rare one by any means, and just a few words concerning it may be appropriate. A

*Abstract of paper presented before the American Institute of Electrical Engineers, New York, December 28, 1898.

glance over a list of our numerous educational institutions causes us to feel proud of our achievements in this line. Endless seem the opportunities which the young American has to acquire the learning and higher education which are prized and cherished in the world to-day. We have schools for every conceivable purpose; we have colleges and universities for every profession, and we have technical institutions almost unmatched in efficiency. But we have only a very few practical trade schools, and for the education of electrical mechanics fewer still. And yet in which field can we utilize, at present and in the future, the greatest number of skilled men in the engineering branch or in the skilled labor branch? The answer must obviously be in the latter. Still parents will persist in sending their children, regardless of their inherent qualities, to the colleges and universities to master a profession without giving a thought to the field in which their future labors must be conducted, without considering the compensation they will receive. And what is the result? There can be only one general reply.

After years of study and much money spent in acquiring the profession, and an early association with children of wealth and refinement, the born mechanic becomes ruined for the sake of experimenting for a genius or a great engineer. The field for mediocre engineers is just as narrow and confined as it is for the mediocre artist; the compensation for his labor is equally curtailed, and, as a result, when the young man is thrown on his own resources he must suffer that genteel poverty which his training in refined circles has bound him to. He can no longer look with pride at the work of his hands, and, his brain power being but the average, he suffers acutely, and eventually becomes neither an excellent mechanic nor an excellent engineer.

Each year the colleges and universities are sending into the world large numbers of young men, who, after years of work, take the title of "Electrical Engineer." How many of these will ever have an opportunity to do any genuine electrical engineering? How many of them are destined ever to earn, in the electrical line, $1000 or so a year, the pay of a skilled mechanic? For every single opening for an electrical engineer there are a hundred openings for the skilled journeyman, and for every successful engineer there are a hundred successful journeymen. And to be a journeyman does not mean to be debarred from engineering.

The compensation for skilled electrical labor, such as journeymen bring into the market, has been on the increase; it will continue to increase, and in an unfair degree, unless those who are the employers do not think in time of a method of supplying the increasing demand, or of making the labor which is offered worth the increase in results achieved. Every new electrical equipment, each railroad equipped electrically and each industry which depends on electricity is taking some of our skilled men from the open market and retaining them permanently and confining their energy to maintaining such equipment. Whence will come the men to replace these defections? Has no one a solution to offer as to the best way of replenishing the supply?

Many methods of solving this problem have been tried, some of them without proper consideration of the case. Some have been the education of journeymen in other trades, such as carpenters, draughtsmen, etc., by means of actual experience during their employer's time; a poor means at best, and one which places the burden directly on the shoulders of the employers, while the resulting mechanic leaves much to be desired in all-around efficiency.

Oftentimes young men, imbued with the desire to be electrical artisans, attend in a desultory fashion popular lecture courses, witness a few experiments in static and galvanic electricity, and find them of such interest that even though they possess little or no qualifications and have been educated and trained for other lines, they determine to make electricity their lifework. Their method of securing the necessary instruction is usually a so-called apprenticeship in a shop manufacturing some article, which, in itself, gives them comparatively little instruction, and which makes them eventually skilled in hand work, without giving them any breadth of training, and merely enables them to fill the position of a slim automatic machine.

Sometimes they read electrical lectures and trade papers, in many instances finding themselves very much at sea because of the technical character of the papers and articles which their previous training has done nothing to enable them to understand. Sometimes, as a final resort, they become recipients of the training offered by correspondence schools, and these schools are certainly gathering an ever-increasing clientèle which their merit justifies.

In many rare instances they attend by far the best and most modern form of securing this training, and that through the trade school. There are, however, such a very few of the latter institutions, in spite of their acknowledged merit, and they are so little known that only a very small percentage of the number who wish to become electrical craftsmen can reap their benefits.

The superiority of the trade school for educating and equipping young men for trade work is so vastly superior to any other form of acquiring the result that to it in the future must we look to solve this very serious problem. Foreign countries have realized this fact for many years and profited by it. Is it not time that this progressive country began to realize it also, and to stimulate and support such institutions? They certainly are bound to spring into existence, and those that exist and have an honorable record are bound to improve that record, and it is but a question of time when intelligent thinkers must give them their proper place and dues.

It has been my good fortune to have been connected with trade schools for some years, notably with the New York Trade School, St. George's Evening Trade School, of New York, and the Highland Falls Trade School, of Highland Falls, N. Y. They have taught me a lesson, which I hope to profit by in the future, not alone concerning the electrical industry but concerning many trades. It is a lesson, however, which applies in an equal measure to them all. And it is that trade schools have an equally high aim and purpose as that of any educational institution in the country; that the field which they cover cannot be covered in any other way, and if they were accorded the same support and encouragement by the fraternity and public that other educational institutions receive, their effect and beneficent influence would be as widespread, if not felt, in even a greater degree, because of the class which they aim to assist.

It seems strange to me that trade schools should be subject to such marked indifference by the employers, and by such intense persecution and criticism by the fraternity which they aim to assist, merely because of the possible future competition their graduates will cause when they come to the journeymen's estate. Was there ever a scientific institution aiming at higher education, a medical college, a law or an art school, but received the support and indorsement of the leaders of the respective professions?

The New York Trade School, owing to the far-sightedness and philanthropy of its founder, Col. Tylden Auchmuty, has been in the field to remedy this coming dearth of skilled mechanics and the crowding-out of our home industries of the native-born American workers by foreign skilled labor. Aided by the munificence of Mr. J. Pierpont Morgan and other gentlemen, it has been able to broaden its scope, until to-day it ranks as the pioneer and largest trade school in the country. With its six thousand graduates it has demonstrated its utility and shown the way to those who wish to follow.

Three years ago it took cognizance of the electrical situation, and immediately inaugurated a thoroughly practical course for electrical workers, which became at once an assured success, filling the class room to its fullest capacity, and having a waiting list of young men eager to enter the classes. The first year the class numbered thirty-two. The second year a larger department was inaugurated, and fifty were accommodated, and still the waiting list continued to be as large. This year fifty are again at work and fully that number were turned away. The course is thoroughly practical, because nothing is taught which is not done by the students themselves and tested and proved before acceptance. This year a course for journeymen workers in the form of practical lessons will be inaugurated. Its success is problematical; but should it show any signs of growth and interest it may lead to future results which cannot fail to be of interest to the whole electrical fraternity.

A Proposed Electric Railway System in Russia.

A consular report from Moscow gives an inkling of the procedure necessary to the establishment of electric railways in that country. The town corporation of Riga desires to establish an electric railway system to cost about $800,000, and has obtained from the Ministry of the Interior the permission to negotiate a loan for the purpose.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering

(NOTE.—Owing to the increasing amount of matter published on electrical subjects, the following changes have been made in the "Digest." Greater space will be devoted to the abstracts of the more important articles, which will be illustrated whenever necessary for clearness. The other articles of the week will be noticed, as heretofore, by references, which will be grouped together in more condensed form, and will not include the large number of articles which appear to be of little or questionable value, or are of an elementary nature, or in general do not appear to be of sufficient interest. The abstracts and references will be limited more strictly to the subject of electrical engineering, as distinguished from physics, chemistry, mechanical engineering, civil engineering, etc. Long serials, when merely referred to, as distinguished from being abstracted, will in general be noticed only once. Digests of patents as a rule will not be noticed. References will, as usual, be given to translations of important articles, or to reprints of articles in the more accessible journals. As heretofore, the author's original phraseology will be used in the abstracts or descriptions of articles as much as possible, especially where the meaning is doubtful or not sufficiently clear; the compiler's criticisms are generally in parentheses. Papers read before American societies, and other articles, reprints or translations which have been published or duly noticed in the other columns of THE ELECTRICAL WORLD, will not again be mentioned in the "Digest.")

Dynamos, Motors and Transformers.

BALANCING ARMATURES.

A short, illustrated article in which the author explains the well-recognized difference between static and dynamic unbalancing of an armature, and shows how to test for both and correct for the former. The usual method of testing is to lay the shaft of the armature on two perfectly horizontal and parallel knife edges, when the heavier side will sink; then tie lumps of solder at various places until it will remain stationary in any position, after which the solder is then permanently secured to some metallic part. A good way is said to be to use a metal ring on the edge of which the canvas head is secured, instead of the fibre disc often used for that purpose; the edge of this is drilled with radial holes before balancing, and the proper holes are then filled with the required amount of solder to balance. A great source of error in this test is due to the shaft of the armature being often very strongly magnetized, which causes it to stick to the knife edges; this difficulty is overcome by using collars lined with some non-magnetic material, or using aluminum bronze rails. He, however, prefers anti-friction wheels to the rails, as they are more sensitive; such a set of wheels is shown. A rough way to test for dynamic balance is to swing the armature in a lathe, the centres being slacked off; if unbalanced it will not revolve centrally. Both ends of the armature should thus be tested separately. He does not explain how to correct for any unbalancing of this kind, but claims that such unbalancing is becoming a thing of the past. An annoying case is the shifting of the centre of gravity due to pulverization of the insulation between the core discs and the shafts. Such an armature cannot be balanced until it is repaired, and this he suggests doing by replacing this insulation material with a cast-iron sleeve or a strip of sheet iron.—Hanchett. N. Y. "Elec. Eng.," Dec. 29.

RECTIFYING ALTERNATING CURRENTS.

The beginning of a mathematical article in which the author discusses theoretically the relations of the quantities involved when an alternating current is rectified by means of what have been termed electric valves, which permit a current to pass in one direction, but not in the other. (The methods of doing this by means of aluminum and carbon plates in an electrolyte, or by means of an arc between a metallic and a carbon electrode, have been fully described in the "Digest.") In addition to the two well-known methods he mentions the property observed by Nichols, in which the sparking distance from a sphere to a point exceeds the sparking distance from the point to the sphere, when the sphere is brass and the point platinum, thus affording a means for obtaining a uni-directional discharge. The cases which he discusses are, first, a simple circuit containing such a valve and a self-induction coil. In the second case there are two valves, and the alternating current passes to the middle point of a solenoidal winding, the ends of which are connected to those valves, the current therefore dividing itself, part flowing through each half of the coil, both magnetizing it in the same direction. The current curves in both cases are reproduced.—Kallir. "Zeit. fuer Elek.," Dec. 18.

COMMUTATION IN DYNAMOS.

A brief abstract of the long article which was noticed in the "Digest" July 23 and June 18. The paper is "an elaborate calculation of the effect on irregularities of either field magnets or armature on sparking in dynamos. It is shown that small interpolar spaces are disadvantageous on account of the variations of the flux due to that armature coil which is under commutation. The author thinks that carbon brushes are always more conducive to sparkless commutation than gauge brushes. He is also of opinion that it is possible to make machines in which there will be reversal of current at the forward polar horns, and which will run sparklessly on account of the dragging of the armature flux by the armature itself for the coils under commutation, by employing a large neutral zone, sufficiently subdividing the armature, and using brushes whose resistances vary progressively."—Girault. Abstracted briefly in "Science Abstracts," Dec.

REFERENCES.

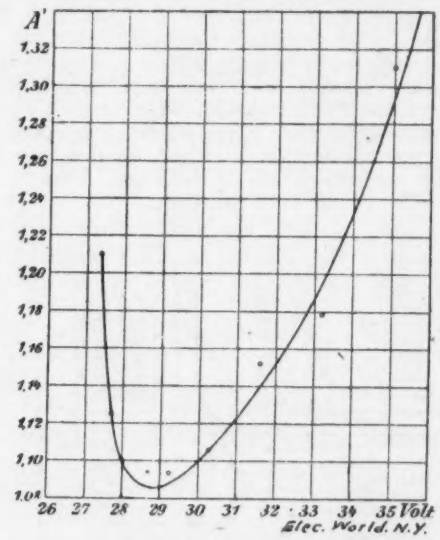
Sparking of Continuous-Current Dynamos.—In a previous article published several years ago by the author he developed a comparatively simple formula, showing the relation between the quantities involved based on the assumption that the current in the short-circuited coil should be broken at that moment when it is equal but opposite to the original current before short circuit. This formula was criticised later by Thomas (see "Digest," March 12), who claimed that it was not correct, as the resistance of the brushes was not considered. He now offered a modified formula. In the present article the author develops what he considers a complete theory of the phenomenon of commutation, and endeavors to show what tests must be undertaken. While his former formula is correct in very many cases, he states that it is not always correct, and does not include all the conditions. The article is theoretical in character. In the present portion no conclusions seem to be drawn.—Fischer-Hinnen. "Elek. Zeit.," Dec. 22.

Electric Generators.—In this installment of the long serial good working drawings and unusually complete data are given for the twelve-pole, 1500-kw, 600-volt railway generator made by the General Electric Company of America, which was exhibited at the World's Fair; also of a six-pole, 200-kw railway generator made by the same company. It is claimed that the constants of the former machine, which were novel at that time, have since become common in the best practice of designing.—Parshall and Hobart. Lond. "Engineering," Dec. 23.

Lights and Lighting.

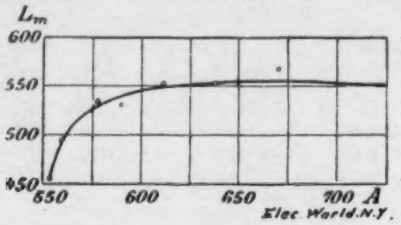
BEST VOLTAGE FOR ALTERNATING-CURRENT ARCS.

A reprint of a short paper, accompanied by a large number of diagrams and tables, in which the author gives the results of a series of tests in which the same lamp was run at different voltages, the light given off being measured in each case. These tests differed



from those of Goerges, published some years ago, in that the amount of energy in each case was not the same, but increased with the length of the arc, as the current was kept constant, namely, 20 amperes. His object was to determine which voltage is the most economical in the production of light, and to find how this voltage compares with that which is the usual practice. All the tests were made with the same pairs of carbons, and therefore with the same current density in the carbons; the results might, therefore, be criticised on the grounds that for different voltages different carbons should have been used. The lamp used was a differential one, which was regulated for the respective voltage. The voltage was varied from 27.4 to 35.0, and for each voltage the light in the two directions of a plane was measured at various angles below the horizon. The curves for the candle power below the horizon at different angles are shown, together with the tables of results. The principal data are then combined in a table and curve, the latter being shown in the above diagram. This gives the relation between the specific consumption

(vertical scale) and the voltage (horizontal scale), by specific consumption being meant the number of watts per candle for the mean hemispherical intensity. It will be seen that this curve has a very decided minimum point, showing that at about 29 volts the consumption of energy per candle is least. According to present practice he states that the voltage generally used is 32. From these figures it also follows that in spite of an increased consumption of energy the mean light intensity remains the same. This is shown in the smaller diagram, which gives the spherical intensity in vertical distances and the number of watts in horizontal distance, and it will be seen that there is very little change in the light intensity for an increase from 600 to 700 watts. For an installation of 110 to 120 volts one could, therefore, use four lamps in series at a voltage of about 28 and at 530 candles, or only three lamps at 35 volts, and approximately the same light intensity. In general it is



recommended to use the minimum specific consumption, and especially is this the case on circuits of 500 to 600 volts. The cause of the difference of the candle power is said to lie in the way in which the carbons burn off at these various voltages. Another test was made with a 25.8 ampere lamp at 30.4 and at 34.8 volts, respectively, which confirmed the previous results, there being a difference of 30 per cent. in the watts per candle power in favor of the lower voltage. He therefore argues that the use of higher voltages with alternating-current lamps is a disadvantage. It appears, however, that in using the lower voltages the regulation of the carbons must be more perfect, as the ends of the carbons are nearer together; it may, therefore, be better not to go too near to the theoretical minimum point shown in the first diagram.—Wedding. "Elek. Zeit.," Dec. 22.

Power.

REFERENCES.

Electric Motor for Small Industrial Purposes.—A short article in which the author outlines briefly the method of extending the adoption of electric motive power by the general manufacturing community. It includes a table showing the number of motors driven by central stations in different towns in Great Britain.—Gibbings. "Cassier's Mag.," Jan.

Distribution of Alternating Currents.—In this continuation of the serial (see "Digest" last week), the installation of transformers, pits and sub-stations are considered.—Ewing. Lond. "Elec. Eng.," Dec. 23. A reprint of this series is begun in N. Y. "El'ty," Jan. 4.

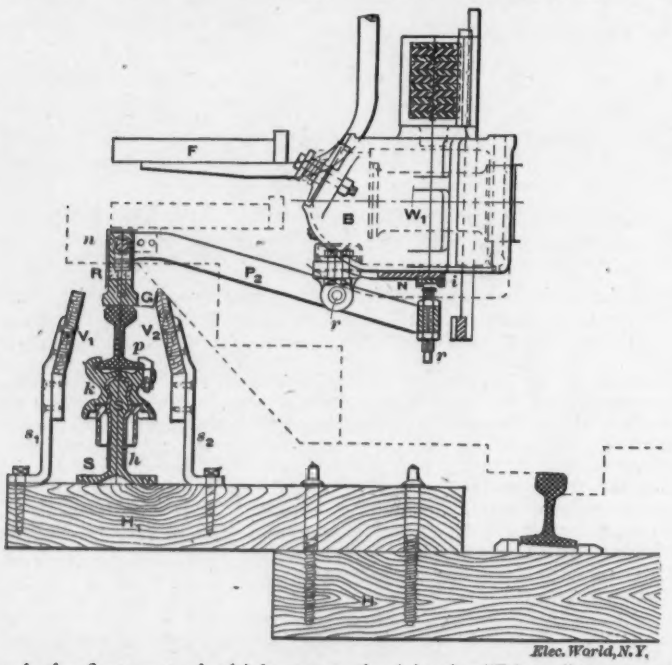
Electrical Stage Mechanism.—A short, well-illustrated article showing the arrangement recently installed at the Drury Lane Theatre, in London, the stage for which is made of six movable platforms operated electrically.—Lond. "Engineering," Dec. 23.

Steam Turbine Dynamos.—Some figures and curves showing the steam and coal consumption in a parallel-flow steam turbine, in pounds per kw output.—Lond. "Elec. Eng.," Dec. 23.

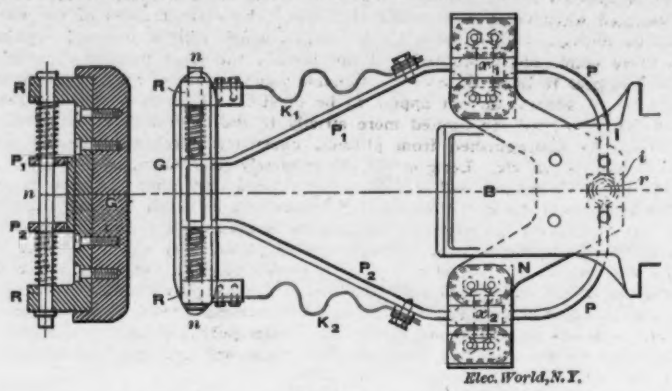
Traction.

ELECTRIC TRACTION FOR HEAVY RAILROAD WORK.

The conclusion of the description of the Wannsee projected rail-



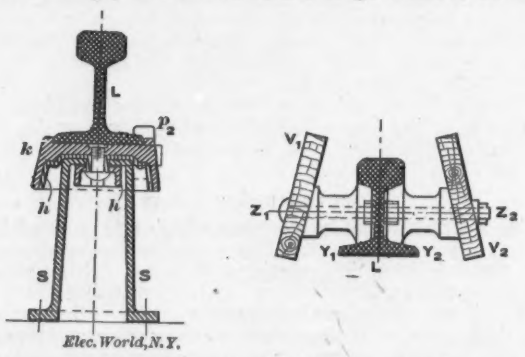
road, the first part of which was noticed in the "Digest" last week. The present portion describes the motors, the third rail, and the method of making contact with it. The motors are suspended without springs, being around the axles and driving directly—that is, without gearing; they are four-pole motors, with only two field coils. The more important part of the system is said to be the arrangement of the third rail and current collector, a full, illustrated description of which is given; the more important of the illustrations are reproduced on this page, which will explain themselves. At the middle axle of the motor car, and on each side, there is a current collector, thus making four such collectors for each train containing two motor cars; these are fastened to the middle of a car because the oscillations are least there. The mechanical connection of the current collector is at the box of the axle, as shown. *G* in these



figures is the shoe or skate which slides on the third rail, and is made of cast iron; it is made so as to be easily removable, and is connected to the arm so as to allow of a slight movement, opposed by springs, in the direction of the sliding motion. The current is led from it by flexible connections, as shown, to the common mains carried on the train and running along its whole length. The contact pressure is due only to the weight of the shoe and the arm. The third rails consist of old, discarded rails connected together with copper bonds. They are insulated from their supports by the layer of insulating material marked *h*, of hard rubber or of a mixture of asbestos and "gum" called asbesonite, which is said to be very strong mechanically, not inflammable, and not affected by moisture; (what gum this is, is not stated, but the German word "Gummi" is also used for rubber, although it really refers to the resinous gum or gum arabic). The resistance of the third rail was found by experimental tests to be 0.0249 ohm per km, and of the return circuit 0.0136 ohm per km. When thoroughly wet the insulation resistance of the third rail was still 52,400 ohm per km, and the loss at 500 volts is therefore only 0.009 ampere. The third rail is protected by inclined boards, as shown by either of the two methods illustrated. The current will be obtained from an existing station to which a battery has been added, it being connected directly without the use of any booster. The power which will be required for one return trip is estimated to be 158.8 hp hours. Concerning the cost of operation, very careful estimates have been made. The cost for 1000 train km with the former steam locomotives was 498 mark ($125), while for the electric system it is only 411 mark ($103), or a saving of 17.5 per cent. This is partly due to a saving of the coal, owing to the diminution of the weight to be moved, and the use of a stationary engine. The maintenance of the motors costs much less, and there will be a considerable saving in the labor required to operate such lines. Very thorough tests are to be made.—"Zeit. fuer Elek.," Dec. 18.

ELECTRICITY ON STEAM RAILROADS.

An article in which the author predicts that within the next fifteen years steam will probably be superseded by electricity as a motive power on even the trunk-line railroads. This change will reduce the time between New York and Chicago to ten hours, and means a general readjustment of business and social conditions to a standard of 125 miles per hour instead of 40. He believes this revolution will come without any great sacrifice in railroad properties, and without radical departure from present methods of railroad construction. The change, he believes, is much more feasible than is thought by railroad men. He goes into the details of the cost of making the change, and shows that a large number of the assets



of present railroads are of a kind which would not have to be changed. He suggests that as fast as a steam locomotive becomes worn out an electric locomotive should be substituted, thus changing the whole equipment in course of time. Besides the great advantage of increased speed there are economies in fuel and repairs.

Five pounds of coal in a steam locomotive will do what 1.5 pounds will do in a stationary plant, and the cost of fuel per hp hour will be brought down to half a cent, or, with gas engines, to still less. The cost of repairs would be enormously reduced, in spite of greater speed, and the track life would lengthen with the gradual elimination of the steam locomotive; moreover, repairs to motors are less costly and less troublesome than to a steam locomotive.—Short. "Cosmopolitan," Jan.; abstracted briefly in N. Y. "El'ty," Jan. 4.

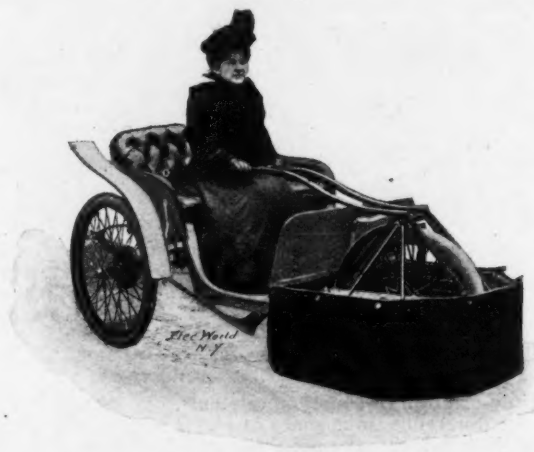
NOTES ON LIGHT RAILROADS.

The first part of the reprint of an address delivered at the Stevens Institute. The author discusses street railroad costs, compressed air traction, and rapid acceleration. In the first portion he endeavors to show that "both horse and cable are doomed, but the latter will seldom be displaced by electricity, because of an estimated decrease in the working expenses." A table is given of the cost per car mile for a year for a conduit electric and a cable road in New York, and for a trolley and cable road in Chicago, which shows that the total cost per car mile of the conduit electric road in New York is 10.23 cents, while for a cable road it is 16.35; for the trolley road in Chicago it is 13.05, and for the cable 10.71. In this the item of maintenance of way is of special interest, as for the New York cable line it is about ten times that for the electric, while in Chicago it is nearly the same for both. Moreover, for the New York cable line it is nearly three times as much as for the Chicago cable line. Another short table gives the relative costs for different kinds of power for some roads of considerable mileage. Brief comparisons are then made with some foreign roads, pointing out the different conditions. The discussion of compressed air traction is then begun. The figures which he gives show that as far as the useful horsepower is concerned, working under restricted conditions, electricity, steam and compressed air are rivals, not one of them showing a marked advantage in the power available at the draw-bar.—A. J. Wood. "Railroad Gazette," Dec. 23.

The N. Y. "Elec. Eng.," Dec. 29, refers to this article editorially, and claims that this comparison is an unqualified use of the original data. It is also questioned what kind of cables are used in Chicago, where the cost of maintenance is so low.

AUTOMOBILES.

A well-illustrated description of a novel form which has recently been constructed in Paris, and is named the "pony." As shown in the adjoining illustration, it is a three-wheeled vehicle, seating two



passengers, the driving and starting being both done by the front wheel. The motor has a power of 550 watts; there are fifteen to twenty cells, weighing 15.4 pounds each and having a capacity of 80 to 85 ampere hours at a discharge of 17 to 23 amperes; this corresponds to a trip on the level of four to five hours, or about 50 to 70 kilometres at a speed of about 15 kilometres per hour. There are four speeds; the first two are obtained with resistances, and the last one by shunting the field of the single-series motor, thereby developing a speed of 20 kilometres per hour (12 m.). The wheels have pneumatic tires. The weight of the vehicle without passengers is 280 to 300 kg (616 to 660 pounds), of which about 200 to 220 kg are on the front wheel and 80 on the rear. The batteries and motor are close to the front wheel. The cost of a trip of 60 km (36 m.) is said to be not more than 3 francs (60 cents), which figure is said to be guaranteed by the contractors (Mildé), including the maintenance of the accumulators and the charging.—"L'Energie Elec.," Dec. 16.

CORK.

An illustrated description of a recently completed plant in Ireland, the distinctive feature of which is that it is a combination of a lighting and railway plant. Much of the machinery is American, the contractors being the British Thomson-Houston Company. There are three tandem-compound condensing engines directly coupled to six-pole, 200-kw generators at 500 volts. There is a battery of 256 cells of a capacity of 770 ampere hours at a seven-hour rate. The battery can be charged either from the traction or from the lighting bus bars, the necessary volts being supplied by a booster, which can also be driven from the traction or the lighting bus bars. The lighting distribution is on the three-wire system, with 460 volts between the outers. The total energy applied for by customers is the equivalent of 14,500 lamps of 8 candle-power. The tariff for light is 10 cents per kw hour for the first two hours, and 2 cents afterward on the Brighton system of charging. For motive power it is 9 cents for the first hour and 2 cents afterward. The two former journals contain also a diagram of the switchboard connections.—Lond. "Elec.," "Elec. Eng." and "Elec. Rev.," Dec. 23.

THREE PHASE INCLINED PLANE ROAD.

A brief, illustrated description of the Mount-Dore road in France, which has recently been completed. The source of power is a neighboring waterfall; the three-phase current at 3600 volts is used, the generator having an output of 12 amperes per phase, the frequency being 50. The transmission line is about two miles long. The receiving motor is at a station at the top of the inclined plane, and operates the cable drum, delivering 85 to 90 horse-power at 3400 volts taken directly from the line. It is claimed that the motor has only half the weight of a continuous-current motor for the same amount of work. There are as usual on such roads two cars passing each other in the middle of the incline; each car carries fifty passengers. The grades range from 26 to 51.6 per cent. and the total rise is 600 feet.—N. Y. "Elec. Eng.," Dec. 29.

RAILWAY STATISTICS.

A short editorial note giving some statistics from the report of the United States Commissioner of Patents for 1897. The growth of electric traction is shown for a few years. The total mileage of electric railways in the United States up to October, 1897, was 13,765 miles out of a total mileage of 15,718, of which only 947 miles are horse-car lines. The total capital invested was $846,131,691, and the number of employees is estimated at not less than 166,000.—"Cassier's Mag.," Jan.

REFERENCES.

Mechanical Power for Traction.—A short article pointing out what it means to save 2 cents per car mile in traction systems. It includes a table which shows at a glance the effect of reducing the working expenses of a railway by this amount, and gives the capitalized value of this saving, showing what investment is warranted thereby.—"Railway World," reprinted in Lond. "Elec. Rev.," Dec. 23.

Submarine Boat.—A brief, illustrated description of the Argonaut, which is said to have traveled over 1500 miles during the past year under her own power, both on the surface and under the water. As will be remembered from previous descriptions, this boat is provided with wheels for traveling on the bottom.—N. Y. "Elec. Eng.," Dec. 29.

Electrical Canal Traction.—In this continuation of the long serial abstract of Van der Wallen's long paper, noticed in the "Digest" last week, descriptions and data are given of a number of the systems in use.—Lond. "Elec. Rev.," Dec. 23. N. Y. "El'ty," Jan. 4, begins a reprint of this series.

Central London Railway.—Some illustrated notes, referring only to the construction of the tunnel.—Rosenbusch. "Eng. News," Dec.

Installations, Systems and Appliances.

REFERENCES.

Commercial Aspects of Electric Lighting in Great Britain.—A short article on franchises, Board of Trade rules, official publications of accounts, etc., in Great Britain, where the annual publication of carefully audited accounts is obligatory. The Board of Trade form of these accounts is briefly outlined, and a small table of costs of working at a few stations is given, showing that in about a dozen stations the total cost of generation and distribution of electrical energy has been brought down to less than 2 cents per kw hour.—Hammond. "Eng. Mag.," Jan.

Salisbury.—An illustrated description of this small plant, in which both water power and steam power are used. The plant contains a battery of 230 cells of a capacity of 715 ampere hours at a nine-hour rate. The turbine runs for about 18 hours daily, charging the cells in the morning and supplying current together with the cells in the evening.—Lond. "Elec. Eng." and "Elec. Rev.," Dec. 23.

Relation of Companies to Municipalities.—An abstract of a lecture at the Purdue University on electric power companies and their relation to municipalities.—Lang. N. Y. "Elec. Eng.," Dec. 29.

Hamburg.—A long abstract of the operating accounts of this station for the year ending last June.—"Elek. Zeit.," Dec. 22.

Electro-Physics and Magnetism.

THEORY OF EARTH'S MAGNETISM.

In an article on the upper regions of the air the author suggests a theory to account for the phenomenon of northern lights, thunderstorms and magnetism of the earth. He argues that we get all our energy from the sun, but that it cannot act like an electrified body or a great magnet, inducing similar effects on this earth. One of the objections to such a theory, for instance, is the necessity of supposing the electric charge on the sun to be very great, and that it is more highly magnetized than the hardest steel; it is hard to believe the latter, owing to the intense state of heat there. It seems evident also that the disturbance of the magnetism noticed on this earth is not caused by fluctuations in the state of magnetism of the sun. Lord Kelvin, for instance, has calculated that fluctuations sufficient to produce the magnetic storm in 1885 would require an expenditure of energy equivalent to the whole light and heat radi-

ated from the sun during a period of four months. The great modern doctrine is that all the energy we receive from the sun is electromagnetic, and that what we term heat and light are really transformations of electrical energy. The sun is therefore undoubtedly concerned in both the phenomenon of the electric state of our atmosphere and the phenomenon of the earth's magnetism. His theory is that the short waves of energy may in some way produce electrical and magnetic effects in the upper regions of the air. Those which are thus transformed fail to manifest themselves as light at the lower altitude. He contends that the light waves are transformed into electrical and magnetic waves; it is now supposed that light, heat and magnetic waves do not differ in any respect except in their wave-length. It is thought that extremely short waves may be produced by electrical discharges in rarefied spaces. Extremely short wave-lengths of light have never been detected at low altitudes, but nevertheless they may exist in the upper regions of the air. He contends that they do exist and produce the electricity of the atmosphere and the magnetism of the earth. One of the reasons why we cannot detect X-rays in the atmosphere is that they may be absorbed, and he suggests that the equivalent of the absorption may be electrical and magnetic energy. X-rays have the property of communicating an electrical charge to conductors; if there are such rays reaching the air from the sun, they could charge the earth on the side toward the sun in the upper regions; this would tend to dissipate and flow toward the other side; this, together with the rotation of the earth, would constitute a flow of electricity, and this, he shows, would be from east to west—that is, opposite to the direction of the earth's rotation. The electrical storms in the lower regions might then result in the disturbance of this charge in the upper regions by means of great commotions in the air. The northern lights may be due to the dissipation through the good conducting layers of rarefied air; thunderstorms would be a local descent of the electrical conditions. The theory that atmospheric electricity is due to evaporation is untenable. The magnetic poles of the earth are so far apart that the magnetism must be due to solenoidal action as distinguished from the action of a permanent magnet. (It would seem, however, that it is the ratio of the diameter to the length which would determine the limit to the length of a permanent magnet.) He claims that the longest permanent magnet which can be made is barely 3 feet in length; the great distance between the poles of the earth is therefore claimed to be a strong argument in favor of the theory of circulating currents. Such currents have not been discovered on the earth, but they may circulate in the upper regions of the air. His theory supposes that the shortest waves of light are converted into electricity in those regions, and the resulting currents are produced by the rotation of the earth. The phenomenon of thunderstorms shows that there may be a high state of electrification in the upper regions, and the increased conductivity of rarefied air shows that those regions have a low resistance. In conclusion he refers briefly to Tesla's suggestion to use the conductivity of these upper regions for transmitting power to great distances. His comments on this have already been noticed in the "Digest."—Trowbridge. "Forum." Jan.

ADJUSTABLE ROENTGEN-RAY TUBES.

After discussing the several ways of making such tubes adjustable, which he had proposed before, the author gives preference to the one in which the anode is fixed and the cathode movable in and out of a glass annex, as the origin of the rays is then a constant point, while a travel of half an inch is sufficient to alter the penetration from the highest to the lowest value. Cathodes should be well polished and accurately curved. "They should not be too small or they become overheated, nor very large, as in that case only the central portion is active. The platinum anti-cathode is best mounted on a massive block of aluminum, to absorb the heat and prevent deformation and blackening. Blackening increases the resistance, not only by occluding the residual gas but also by forming a non-fluorescent coating on the glass. The quantity of X-rays and their penetrative value are distinct. The latter depends largely upon the potential difference, but is independent of the material used for the anti-cathode. The quantity is, however, greatest with anti-cathodes of the highest atomic weight."—Swinton. "Arch. of the Roentgen Ray," 2, p. 40; abstracted in "Science Abstracts," Dec.

This is followed in the latter journal by a notice of another paper by him on the pin-hole Roentgen-ray camera which he used to compare the active anti-cathode areas in the various forms of tubes, with a view to finding the best design for the sharpest definition. The original is contained in the "Arch. of the Roentgen Ray," 3, p. 15. This is followed by an abstract of another paper by him on the source of the Roentgen rays in focus tubes, from the "Roy. Soc. Proc.," 63, p. 432, and "Nature," p. 286. He investigated the source with a pin-hole camera and found that the cathode stream usually proceeds almost entirely from the small central portion of the cathode. The main source of the rays is the anti-cathode, but an appreciable quantity also proceeds from those portions of the glass which show green fluorescence, due to Thompson's paracathodic rays, starting from the anti-cathode.

CAPACITY AND RESONANCE EFFECTS OF CONCENTRIC CABLES.

Several answers to a request to explaain these two effects. The capacity effect of a concentric cable is shown when it is connected to an alternator of considerable inductance or to step-up transformers, by a raising or a lowering of the terminal pressure; it is sometimes called the Ferranti effect. Siemens, who investigated it thoroughly, found that the voltage at the secondary terminals of a transformer was increased as the length of cable attached, and it increased up to a certain point and then for greater lengths it diminished again, ultimately getting much less than the pressure with no cable attached. In some experiments the pressure was increased to 400 per cent. of its initial value. The resonance effect is quite different, although the two were thought at one time to be the same. This does not alter the pressure in the circuit, but may give rise to large circulating currents. It arises in certain cases when there is a capacity and an inductance in parallel, such as when there is a long concentric main feeding a bank of transformers at the distant end. The relations between the quantities involved are discussed mathematically with the aid of comparatively simple formulas.—Lond. "Elec. Eng.," Dec. 23.

RESISTIVITY OF STEEL.

Two papers, in the first of which the author tested various specimens of steel containing different percentages of carbon, manganese and silicon. The table of results is given in the abstract. They show that the resistance increases with the amount of carbon at an average of 7 microhms for 1 per cent. of carbon by weight; there is an increase of 14 microhms per 1 per cent. of silicon by weight, and an increase of about 5 microhms per per cent. of manganese by weight. The specific resistance in microhms per cu. cm. varied from 10 to 19 in the various specimens. The influence of nickel, chromium, tungsten and molybdenum are also dealt with, but the results are not given in the abstract. The second paper is on the effect which tempering has on the resistivity of steel. It shows the increase of resistance after tempering at various temperatures, and in all cases the resistance increases with the increase of temperature up to a limiting value, depending on the constitution of the steel.—Le Chatelier. "Comptes Rendus," 126, p. 1709 and 1782; abstracted in "Science Abstracts," Dec.

RESISTANCE OF ELECTROLYTES TO ALTERNATING CURRENTS.

In an article on the thermal phenomenon in condenser circuits the author describes experiments which confirm the theoretical deductions of Stefan, according to which the distribution of high-frequency alternating currents in an electrolytic conductor should be the same for all frequencies, and there should be no difference between the resistance to high-frequency alternating currents and to steady currents; as is well known there is such a difference in metallic conductors, as the high frequency-currents tend to keep to the surface. In his experiments he showed that the specific resistance of an electrolyte was the same for condenser discharges as for steady currents. The experiment also suggests a new method of measuring electrolytic resistance which is free from any of the inconveniences of the present method.—Cardani. "Nuovo Cimento," 7, p. 23; abstracted in "Science Abstracts," Dec.

REFERENCES.

Terrestrial Magnetism.—The December number of this journal contains a reprint of the report of the permanent committee on terrestrial magnetism and atmospheric electricity to the International Meteorological Conference; (see "Digest" Dec. 3). A short article by Stupart on the Toronto Magnetic Observatory. The conclusion of Abbe's very long article on the altitude of the aurora above the earth's surface. Also some reviews of books and a few abstracts of articles on terrestrial magnetism.—"Terres. Mag.," Dec.

Coherers.—A description of some experiments in which the coherer action was studied under the microscope. The experiments make it very probable that in some cases at least the reaction of the coherer is a purely electrical process.—Arons. "Annal. Phys. Chem.," 65, p. 567; abstracted briefly in "Science Abstracts," Dec.

Electro-Chemistry and Batteries.

EXPERIMENTS WITH ACCUMULATORS.

A brief description of some experiments, one of which was to determine the difference in capacity of plates which have been formed once, and those which have been re-formed—that is, reversed. The two outside plates of a thirteen-plate accumulator were removed and the remaining eleven plates reversed; the capacity was then found to be 160 ampere hours. A similar cell containing eleven plates, but not reversed, had a capacity of 96 ampere hours, thus showing the great gain in the re-forming. He states that this also furnishes a proof that the spongy lead and the peroxide are not finely enough divided for obtaining a large capacity; the finest subdivision can only be obtained chemically or electrolytically. The second test showed the difference between a compressed plate and one which was not compressed; the former was compressed with a pressure up to 150 atmospheres, and with the same strength of current for charging and discharging, the capacity of the compressed plate was exactly double that of the other. In conclusion he states that his experience has been that cleaning badly sulphated plates with the current, with zinc sulphate and zinc, as also with the carbonate and acid, are not satisfactory. The only satisfactory way is to secure two zinc plates on the two sides of the plate to be treated and place it in a 25 per cent. solution of hydrochloric acid; in twenty-four hours almost all of the sulphate will have been changed into lead. It is only necessary to see that there is always an excess of zinc present, so as to prevent the formation of lead chloride. This method is also well adapted for recovering the lead from the scrap material in accumulator factories.—Borntraeger. "Elek. Anz.," Dec. 22.

STORAGE BATTERIES FOR ROAD TRACTION.

A translation in abstract of the description of the Valls accumulator noticed in the "Digest," Dec. 31, is followed by a comparison of the data with that of the Fulmen battery. Besides giving various other figures, the comparison is made by a method due to FitzGerald, in which the distances are found over which any weight

of the given batteries would transport itself only, supposing the conditions of traction to be the same; in such a method of comparison the values of the batteries are expressed by distances. This distance through which the battery would transport its own weight only is equal to the quotient of the total traction load to the battery multiplied by the distance over which a given weight of battery will convey, at a given speed, a given traction load, including its own weight. According to this formula the figure for the accumulator used by the London Cab Company is 107 miles; for the "very light" Valls accumulator it is 139 miles, and for the Fulmen, under the conditions prevailing at the recent Paris test, the distance varies from 147 to 248 miles, according to its use on the various carriages.—Lond. "Elec. Rev.," Dec. 23.

IMPROVEMENTS IN LEAD ACCUMULATORS.

In an editorial extract of the original paper the statement is made, among others, that Lucknow forms plates in a few days, "if the electrolysis of a very dilute, neutral or faintly acid or alkaline solution of salt, of the alkali or alkaline earth metals be carried on by a moderately strong current in one direction between lead plates." It is also claimed that Guelcher has made an important advance in lessening the weight of an accumulator of given capacity, by making his plates of a fabric the warp of which is lead wire and the weft of glass wool, to which the finely divided active material firmly adheres; the finished plates are cased in glass wool. This accumulator is said to have not more than one-third or one-half the weight of an ordinary cell of equal capacity.—Foerster. "Chemiker Industrie," 21, p. 47; abstracted briefly in Lond. "Elec. Rev.," Dec. 23.

MANUFACTURE OF CHLORATES, BROMATES AND IODATES.

A paper in which, among other observations, the author states that when the anode chamber contains the bi-carbonate of an alkali and the cathode chamber a saturated solution of the corresponding chloride, a diaphragm separating the two, then a complete reversion of the chlorine into chlorate occurs in the anode compartment of the cell. The carbon dioxide is liberated as a gas at the anode, and may be used to form fresh bi-carbonate with the hydrate produced at the cathode. The temperature was between 60° and 70° C., and the current density between 45 and 90 amperes per square foot, the yield of chlorate being greater at the higher current density, the e. m. f. was 4 to 6 volts, and 5 grams of sodium bi-carbonate were added to each 100 cb. m. of anode liquid at intervals of four hours. Bromates and iodates of exceptional purity can be produced by the same method.—Vauvel. "Chem. Zeit.," 22, p. 331; abstracted in Lond. "Elec. Rev.," Dec. 23.

REFERENCES.

Recovery and Refining of Nickel.—A short and interesting summary, like the others published by that author, giving brief descriptions of the various processes, together with a number of the important properties of the metal.—Cowper-Coles. Lond. "Elec. Rev.," Dec. 23.

Electrochemical Dissociation.—An article in which he claims that he has acquired sufficient data to show that the hypothesis of electrolytic dissociation is superfluous.—Traube. "Ber. der Deut. Chem. Ges.," Vol. 31, p. 154; translated in abstract in the Lond. "Elec. Rev.," Dec. 23.

Units, Measurements and Instruments.

ALTERNATING-CURRENT WATTMETER.

A description of a wattmeter on the principle of the d'Arsonval galvanometer, the fixed magnet being energized by the main current, and the moving coil taking current from a shunt across the mains. "The axis of the moving coil is perpendicular to the plane of the horseshoe fixed magnet. The shunt consists of an inductionless resistance, one end joined to one main, the other to two resistances in parallel; of these, one is inductionless and completes the circuit directly to the other main, and the other is inductive and completes the shunt circuit through the moving coil. The object of the small inductive resistance inserted in series with the moving coil is to balance the effect of the hysteresis in the main circuit. The latter produces a phase difference of about 5°, and by suitably adjusting the inductance of the shunt circuit, according to calculations given in the paper, a similar phase difference is created in the shunt circuit and the effect of hysteresis balanced at any frequency."—Behn-Eschenburg. "Ann. Ass. Suisse Elec.," 8, p. 43, 1897; abstracted briefly in "Science Abstracts," Dec.

REFERENCES.

Electrochemical Equivalent of Silver.—A long description of the new determination made by the authors of the electrochemical equivalent of silver, a short reference to which was noticed in the "Digest" Sept. 24. The value which they found is 0.0011192 + per ampere per second. An illustrated description of the electro-dynamometer which they used is given.—Patterson and Guthe. "Phys. Rev.," Dec.

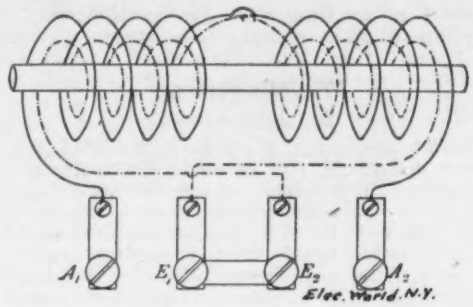
Insulation Indicator.—A long translation in abstract, with many of the illustrations, of the article abstracted in the "Digest" Nov. 5 and 12.—Kallmann. Lond. "Elec.," Dec. 23.

Galvanometry of Spark Discharges.—A more complete and illustrated abstract of the article than the one noticed in the "Digest" Dec. 17.—Witting. "Science Abstracts," Dec.

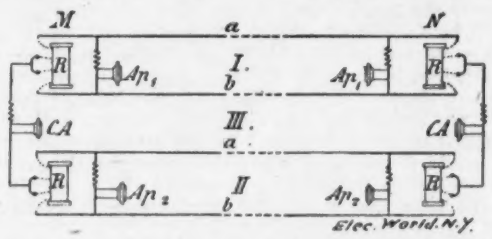
Telegraphy, Telephony and Signals.

MULTIPLEX TELEPHONY.

In a long article illustrated with a number of diagrams the author reviews the various methods which have been proposed, shows wherein they have failed and then describes his method which is in use on quite a number of long-distance lines in Germany. The original method, which was tried about fifteen years ago, is based on the principle of the Wheatstone bridge, the metallic circuit being used for one of the transmissions, while for the second the two wires are used in parallel and with an earth return, suitable resistances being inserted at the ends, where the two lines are connected together. Another arrangement was a similar metallic circuit for the return in place of the earth, somewhat like that shown in the diagram, thus enabling three independent messages to be sent over four lines and without any earth connections. But these were not a success, the reasons being explained. The Elsasser improvement is also described, in which the resistances were replaced by differentially wound coils; although an improvement, it does not seem to have been satisfactory, either. It is claimed that the failure of all these is not due to the fundamental idea but to the construction of the coil connecting the ends of the loop. He then describes his method, which is now used by the telephone department of the German Government. It consists essentially in the winding of the coils *R* in



the second of the adjoining figures; this is wound as shown in the first figure, namely, with four coils, two of which are inside and two outside, each inside one being connected in series with the outside one at the other end of that coil, as will be seen in the first figure. This coil is said to have given excellent results. As a rule the two intermediate binding posts are permanently connected, as shown. These coils are connected as shown in the second figure, which is self-explanatory, these coils being marked *R*; in this way three messages may be sent over two metallic circuits without any connection with the earth. The two metallic circuits should if possible be on the same line of poles and have about the same length, or otherwise the transmission will be interfered with by the noises and other disturbances. It is not important that the resistance of one metallic circuit should be exactly equal to that of the other, and in this respect it differs from the American system. All that he says with reference to the method of calling is that on the German Government lines the calling is done by means of a continuous current. He then describes several modifications of his method; for instance, the telephone at the extreme right may be at a considerable distance from the two coils *R* to which it is connected. Or the four wires may be continued, making two loops to instruments at distant stations; or instead of the telephones which are shown connected directly to the metallic circuit an induction coil may be used for transmitting the message to a distant telephone. It is also shown how the metallic circuits may be used by intermediate stations. Various other modifications are described and shown by means of diagrams. It seems that this system is used on quite a number of long-distance lines in Germany, lists of which are given. The switch which is used for making some of these connections is illustrated and described. The application of this method is not limited to the telephone, but may with some slight changes be used for simultaneously telegraphing and telephoning over the metallic circuits. In this case a single metallic loop may be used, the telegraph circuit being connected between the junctions of the two lines at their ends, and the ground, the two wires being used in parallel for the telegraph currents with an earth return, while for the telephone only the metallic circuit is used. In this case the telegraph signals should be



made less abrupt by means of a graduator and condenser. In this way the Hughes apparatus is in use on the telephone line between Berlin and Frankfort-o.-M., as also between Berlin and Vienna, a distance of 661 km. The arrangement shown in the second diagram with two loops and the Hughes apparatus was also tried with success when the insulation of the line is good, but it is difficult to keep the insulation sufficiently high in all four parallel wires. With the Morse system in place of the Hughes, faults in the insulation are not nearly so disturbing.—Schwensky. "Elek. Zeit.," Dec. 22.

REFERENCES.

Selector System.—An illustrated description of his system for connecting many telephone stations to one circuit. The system now in

common use, called the "bridging bell system," has the serious objection that all bells across the circuit ring simultaneously when operating the line to call a station, thus involving code signals, which are confusing, and this is overcome by his system, which is said to be in operation at the present time on the largest selective step-by-step party plant every placed in operation. There are fifty-three telephones connected to one circuit, and the system has been in operation for two years.—Drake. "Elec. Eng'ing," Dec.

Electrical Intercommunication in Railway Trains.—The continuation and conclusion in the former journal of the reprint of the paper noticed in the "Digest" last week. The discussion is reprinted in the former and abstracted in the latter journal.—Langdon. Lond. "Elec. Eng." and "Elec. Rev.," Dec. 23.

Telephone Batteries.—A short article on "Batteries for Exchange and Toll-Line Use from the Point of Economy and Excellence of Service."—Dinsmore. "Elec. Eng'ing," Dec.

Party Lines.—In this continuation of his long serial he discusses what are called the strength and polarity systems.—Miller. "Elec. Eng'ing," Dec.

Listening and Ringing Equipment for Switchboards.—An illustrated description of this equipment.—Clausen. "West. Elec.," Dec. 31.

Miscellaneous.

LIGHTNING RODS.

A long editorial discussion of a book by Findeisen, which is thought to show considerable progress in the protection of buildings from lightning. The system which that author proposes enables protection to be obtained by simpler and cheaper means than heretofore. His ideas are based largely on practical experience over many years, as distinguished from theoretical reasonings; his method involves nothing new theoretically, but the details of construction are claimed to be of value. His system is said to agree entirely with the theoretical knowledge of the present time; although different views are still held whether lightning is an oscillating or a direct discharge, there is a tendency to believe them to be the former, yet observations have shown repeatedly that lightning discharges also exist which are of the nature of a direct current flowing for a short time. Too much importance, however, has been given this question, which is really of very little importance in the science of lightning rods, as that direct current starts and stops very suddenly. When a variable current flows in a conductor the apparent resistance due to self-induction is proportional to the changes of the current with respect to time; if, therefore, the same current flows through four conductors of the same length and cross-section, the changes in each conductor are only one-fourth as great as before, and therefore the apparent resistance of each conductor is reduced to one-fourth and the total to one-sixteenth of that of a single rod. If it consists of a single rod the apparent resistance may be so great that the lightning has a tendency to branch in order to diminish the apparent resistance, and it will do this through neighboring paths, even though they may have a higher ohmic resistance; it is therefore absolutely necessary to use all such paths as conductors. Not only should all large metallic parts of a building be connected to the lightning rod, but these connections should be continued to earth, which formerly was not always done. When all are connected to the same earth plate, then the whole discharge must pass through it and the apparent resistance on this common path may become so great that the lightning will tend to find other earths. In the Findeisen system all the natural paths in a house are included in the circuit and are led to earth through different paths. Moreover, it is not necessary to reach ground water with the earth plates, as it is sufficient to bury them near the upper surface in moist earth. This may be done owing to the fact that the charge which the lightning equalizes is located on the upper surface of the earth; such earth plates are better, notwithstanding that they may have a higher resistance, as it is almost immaterial whether the contact resistance with the earth is one or several hundred ohms; it is not the absolute, but the relative, value of the resistance of the earth contact as compared with the other parts of the building, which is important; the earth contacts must lead off the lightning much easier than any other parts of the house. He therefore insists that gas and water pipes should be connected with the lightning rod, for a better earth connection could not be found. There is, then, no longer any danger that lightning, in jumping to these pipes, will cause damage, and experience has shown that the pipes are not injured thereby. Findeisen does not accept the idea that the principal action of a lightning rod is that of equalizing the charges by means of a silent brush discharge; while experience in certain cases has shown that it may act in this way, it is thought in general to be a very unimportant part of its function, and in practice need not be considered.—"Elek. Zeit.," Dec. 22.

IMMUNITY OF FACTORY CHIMNEYS FROM LIGHTNING DISCHARGES.

In order to investigate the cause of the comparative immunity of factory chimneys from lightning discharges, the author reproduced the condition as far as possible in the laboratory. The results lead him to the conclusion that the immunity of chimneys and the effects observed should be ascribed to the presence of streams of gases of certain substances or of certain temperatures and velocities.—Wesendonck. "Annal. Phys. Chem.," p. 553; abstracted in "Science Abstracts," Dec.

ATMOSPHERIC DISCHARGES.

A theoretical article, the principal formulas of which are reproduced in the abstract. He concludes from these that if there are two induced circuits, in one of which the ratio of the resistance to the coefficient of self-induction is very great and in the other very small, it may be possible by measuring certain quantities in the two cases to determine the nature of atmospheric discharges.—Montel. "L'Eclairage Elec.," 16, p. 183; abstracted in "Science Abstracts," Dec.

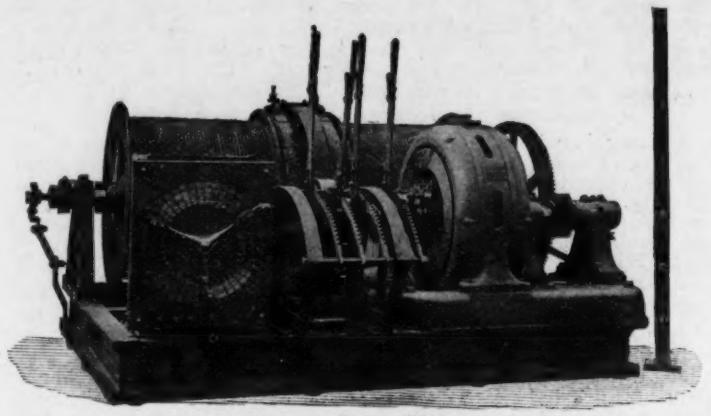
REFERENCES.

Electrical Engineering Courses.—An abstract of a paper in which brief descriptions are given of a number of the continental colleges where electrical engineering is taught.—Puluj. "Zeit. f. Elek.," Dec. 18.

Naval Electrical Engineering Corps.—A short article on the necessity of such a corps. (The author was the late chief engineer of the U. S. S. Nashville.)—Roller. N. Y. "Elec. Eng.," Dec. 29.

Double Drum Hoist and Electric Motor.

The electric hoist illustrated herewith shows one of the recent applications of a General Electric induction motor to a double independent drum Lidgerwood mine hoist. It is compact in form, and the levers controlling the clutches and brakes and handle of the rheostat are placed in the position most



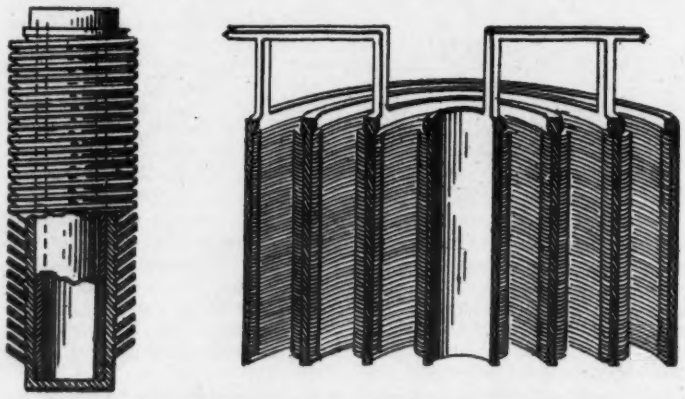
Double Drum Hoist.

convenient for control by the operator standing on a platform above the floor and having a clear view over the top of the hoist.

Each friction drum is driven through a single-reduction gearing by a 100-volt, twelve-pole induction motor of 30-hp capacity, running at 600 r. p. m. Each drum is independent and is 42 inches in diameter by 40 inches face. Together, they hold about 420 feet of ¾-inch rope. The maximum hoisting speed is 300 feet per minute, and the weight hoisted, i. e. load, car and cage, 2100 pounds. The depth from which the load is to be hoisted is 400 feet from the surface.

A New Storage Battery Patent.

A novel modification of the Willard storage battery is described in patents Nos. 617,003 and 617,004, issued January 3, 1899, to Mr. E. T. Willard and assigned to Messrs. Sipe & Sigler, of Cleveland, Ohio. The patent claims an arrangement of the plates in cylindrical form somewhat similar to the original Planté cells, a nest or group of cylinders of different sizes being arranged one within another and connected up alternately positive and negative. These cylinders have the usual ledges, shelves or projections formed in this case into



New Form of Storage Battery Plates.

a continuous helix from top to bottom of the cylinder and inclined upward and outward, giving a series of saucer-shaped shelves. Similar projections may be formed on the inside of the cylinders. These dish-shaped ledges give more durable retaining walls for the active material. The patents also describe a battery made up of a large number of these tubular electrodes, small in diameter and not concentric, the ends being hermetically sealed and containing a solid stiffening core, the whole giving a form designed to stand the severe buckling and warping actions of the abusive service of electric vehicle work.

NEWS OF THE WEEK

Financial Intelligence.

THE NEW YORK & NEW JERSEY TELEPHONE COMPANY has declared a dividend of 1½ per cent. and an extra dividend of 1 per cent., payable on January 16.

LARGE INCREASE OF CAPITAL.—The board of directors of the People's Light & Power Company, Newark, N. J., has decided to increase the capital stock of that concern from $5,000,000 to $20,000,000, in view of the absorption of the Hoboken and Elizabeth electric light companies. At the same meeting it was resolved that a material reduction should be made in the charges for lighting, and a number of improvements were authorized. The People's Company, it is stated, has no bonded indebtedness, and the officers say that not more than one-third of the authorized increase in stock will be issued at present.

MANHATTAN AND GENERAL ELECTRIC STOCKS on January 5 made some remarkable advances. It was reported that the Metropolitan Street Rail- Company had made an agreement for control of the Manhattan Railway on the basis of an exchange of stock, but this rumor was denied. Another report was that the Manhattan had awarded to the General Electric Company a contract for equipping its road with the electric system. This latter report, which could not be verified, was the main factor in causing the advance in the stocks of both companies. Manhattan made a net gain for the day of 4 per cent., and General Electric 3¾. General Electric closed at 99¼, after having passed 100.

GENERAL ELECTRIC DIVIDENDS.—A Boston dispatch states that the directors of the General Electric Company have declared a dividend of $3.20 on the preferred stock of the company as reduced. This, it is stated, is the first dividend, and applies from earnings between August 17 last, when the capital was reduced, and January 31, 1899. The directors also declared a dividend of $11.66 2-3, applicable to the unpaid accumulated dividends on the preferred stock. This dividend is equal to $7 per share as it existed prior to the capital reduction, and is equivalent to one year's dividends at the rate of 7 per cent. on the unreduced preferred stock. The directors have now declared on the accumulated dividends two disbursements of $11.66 2-3, and one disbursement of $17.50, or a total of $40.83 1-3. There now remains unpaid $19.05 2-3 of the total $59.89 accumulated on the new share basis. The two dividends above referred to are payable on January 31 to stock of record January 21. It is stated that the unpaid balance of $19.05 2-3 will probably be disbursed within the next two or three months, when consideration will be given to the payment of dividends on the reduced common stock.

Special Correspondence.

NEW YORK NOTES.

THE AMERICAN GRAPHOPHONE COMPANY on January 10 gave an exhibition at the Waldorf-Astoria, to some invited guests, of its latest improved graphophone, which is remarkable for its power of production. The new machine reproduces not only with great volume, but with great naturalness and purity of tone.

COMPRESSED-AIR-DRIVEN TRUCKS FOR NEW YORK.—A dispatch from Worcester, Mass., on January 5, states that the American Wheelock Engine Company, of that city, had received from the New York Auto-Truck Company an order to build 250 auto-trucks for use in the streets of New York. According to the specifications, each truck must have a carrying capacity of 10 tons at a speed of 8 miles an hour. They must be able to run 25 miles on one charge of air.

THE AFFAIRS OF THE NEW YORK GAS, ELECTRIC LIGHT, HEAT & POWER COMPANY.—It is stated on what seems to be good authority that the Edison Electric Illuminating Company, of New York, has passed, or is about to pass, into the control of the New York Gas, Electric Light, Heat & Power Company. The Edison Electric Illuminating Company was organized on December 17, 1880, and owns and operates six central stations in various parts of the city.

NO MORE LONG-DISTANCE TELEPHONE CALLS FROM MUNICIPAL BUILDINGS.—The bills for long-distance telephone calls during the last year coming from public buildings were so large that Commissioner Kearney, of the Department of Buildings, Lighting and Supplies, has directed the telephone companies to pay no attention hereafter to requests coming from city buildings for long-distance connections. It is stated that many of these calls during the past year were of a private nature.

NEW TELEPHONE EXCHANGE.—The New York Telephone Company has opened its new exchange at 112 West Eighty-ninth Street. The new exchange, which is known as "Riverside," will handle the business in the district bounded by Seventy-second and One Hundred and Tenth Streets, Central Park and the Hudson River. It has a capacity of 3500, and starts out with 800 subscribers taken from the Columbus exchange. It is operated on the central energy system, using incandescent lamps as calling signals.

INDICTMENTS AGAINST THE WESTERN UNION TELEGRAPH COMPANY.—The Western Union Telegraph Company as a corporation and John B. Bertholf, Jersey City, manager, individually, have been indicted by the Hudson County, N. J., Grand Jury for aiding and abetting "green goods" swindlers by knowingly permitting them to carry on their business over the company's lines. The indictments were handed to Justice Lippincott last Friday, and Manager Bertholf was required to give bail to await trial. The officers and directors of the Western Union Telegraph Company will be summoned to plead to the indictment.

DEBTS OF STREET RAILWAY COMPANIES FOR PAVING.—The Commissioner of Accounts has reported to Mayor Van Wyck that $875,460.30 is due the city from street railway companies of this city for work done in paving and maintaining the streets within the rails and for 2 feet on each side of them, which work the companies, in their charters, agree to perform. These charges, from 1889 to 1898, aggregating the amount given above, it is stated, still remain unpaid by the railroad companies. The largest indebtedness is that of the New York & Harlem Railroad, the amount being $164,709.62. The next largest is $80,950.67, of the Second Avenue Railroad Company.

REORGANIZING THE BROOKLYN ELEVATED RAILROAD.—It is stated that the Brooklyn Elevated Railroad will be taken out of the hands of the receiver on or before February 1 next. At a meeting of the reorganization committee, held on January 5, the incorporation of a new company was authorized. The new company will be called the Brooklyn Union Elevated Railroad, and will acquire all the property and franchises of the Brooklyn Elevated, Union Elevated and the Brooklyn Bridge and Seaside Elevated railroads. The plan of reorganization provides for the issue of about $12,000,000 in first mortgage bonds, $3,300,000 5 per cent. preferred stock and $13,000,000 common stock.

THE LATEST PROGRESS IN STORAGE-BATTERY INSTALLATIONS.—This was the title of a lecture delivered by Mr. Joseph Appleton before the 193d meeting of the New York Electrical Society, which was held at the College of the City of New York on Thursday evening, January 12. The lecture was illustrated by slides, photographs and diagrams, showing the most recent development in storage-battery central lighting stations, railway and power plants; the different methods of operation and control; battery stations with rotary converters; office buildings with electric elevators and isolated plants, etc. After the lecture a visit was paid to the storage-battery power sub-station of the Metropolitan Street Railway Company at the foot of West Twenty-third Street.

A SMART PIECE OF JOURNALISTIC ENTERPRISE.—The publication offices of "Locomotive Engineering" were destroyed by the fire which damaged the Home Life Building on the night of December 4 last. The fire left the paper without either cuts or copy for the January issue, and, in fact, left little else but the contents of the safe and the title of the paper. This misfortune, however, did not discourage the managers at all. Undaunted, they started from the very beginning on the January paper, and produced an issue that would be a credit in ordinary times. Necessarily the paper was entirely new, and the amount of energy and enterprise to get it out was prodigious. The result is in every way remarkable, and our contemporary is entitled to congratulations on its success in producing an entirely new paper in such a short space of time. The new office of "Locomotive Engineering" is at 95 Liberty Street, New York.

A REPORTED CARBON TRUST.—A dispatch from Chicago states that a new concern to be known as the National Carbon Company will be incorporated under the laws of New Jersey on January 16, and will purchase and control many of the well-known carbon manufacturing companies of the country. The capital of the new company will be $10,000,000, of which $4,500,000 will be non-cumulative 7 per cent. preferred and $5,500,000 common. It is stated that contracts have been made for the purchase of the plants of the following-named companies: National Carbon Company, Brush Carbon Works, Standard Carbon Works, Crouse & Tremaine Carbon Company, Fostoria, Ohio; Thomson-Houston Carbon Company, Fremont, Ohio; Faraday Carbon Company, Jeannette, Pa.; Phœnix Carbon Manufacturing Company, St. Louis; American Carbon Company, Noblesville, Ind.; Washington Carbon Company, Pittsburg, Pa.; Partridge Carbon Company, Sandusky, Ohio. It is also stated that in addition to these concerns the new company will own a half interest in the Ottawa Carbon Company, of Ottawa, Ont., which controls the carbon industry of Canada. The home office of the new company is not stated.

ELECTRICAL EXPORT TRADE.—Manufacturers of and dealers in electrical apparatus are making extensive preparations for a large export trade of apparatus and supplies. The newly acquired national territory is evidently looked upon as a promising field for enterprise and activity in electrical lines, and considerable briskness prevails in some branches of the trade just now in arranging plans for the handling of this new business. In referring to the general subject of the export trade of electrical apparatus the "New York Journal of Commerce and Commercial Bulletin" of recent date states that it is growing not only with England but with the British colonies, especially with South Africa and New Zealand. There is hardly a vessel leaving this port in which there are not large consignments of electrical machinery and electrical appliances. Mines in the neighborhood of Johannesburg have recently made large calls on the manufacturers, and at Cape Town and Port Elizabeth the electric equipments for street railways have been installed by American firms; cotton mills in India, Japan and China have also been fitted with electric lighting machinery from the United States, and American electric locomotives for use in mines are being sent to all parts of the world. If the amount of estimating being done at present by manufacturers for electrical material required abroad is an indication of what may be expected of the trade during the year, the foreign business in anticipation will eclipse all previous records for so early in the season. Excepting the steel and oil refining industries, there is no industry in this country which prides itself more on its ability to handle foreign business than the electrical industry.

NEW ENGLAND NOTES.

MR. STUART W. WISE, who was formerly treasurer of the Manhattan General Construction Company, has opened an office in the John Hancock Building, 178 Devonshire Street, Boston, Mass., the former New England ad-

dress of the Manhattan company. Mr. Wise will push the sale of the Manhattan enclosed arc lamps from this address. The company manufactures lamps for direct-current circuits to operate singly on 110 to 220 volts, two or more in series on 220 to 550 volts, and to operate singly or in series on alternating-current circuits.

A DINNER was given at the Parker House, Boston, on Friday evening, January 6, by Mr. C. S. Knowles, engineer and dealer in electrical supplies and specialties, and his manager, Mr. J. H. Parker, to the territorial and department heads of the business, as an expression of personal esteem and appreciation of their earnest efforts during the year 1898, which was a particularly successful one. The following-named gentlemen were present: C. S. Knowles, J. H. Parker, W. O. Turner, manager of New York office; C. L. S. Tingley, manager Philadelphia office; S. A. Cosgrave, Jr., manager Pittsburg office, and the following heads of departments: James W. Tucker, cashier; Frank W. Ferrin, wires and cables; H. D. Sears, power transmission; Percy Hodges, electric railways; George A. Ober and Henry A. Cole, New England representatives. All these gentlemen are hard workers and popular, and manage to capture considerable business.

Buffalo and Niagara Falls Notes.

ELECTRIC POWER IN THE BUFFALO "EXPRESS" OFFICE.—It is reported that the Buffalo "Express" is about to introduce electric power, obtained primarily from Niagara Falls, for the purpose of running its presses.

THE URBAN ROLLER MILLS.—The electric power plant at the Urban flouring mills is complete, and will be supplied with power from Niagara Falls by the Cataract Power & Conduit Company on January 9, at 2200 volts, three-phase.

THE ROCHESTER CAMERA COMPANY, Rochester, N. Y., has contracted with J. C. Sterns, of Buffalo, to install an electric lighting plant, consisting of 500 incandescent lamps, 16 enclosed arcs and one 500-light and one 50-light Westinghouse generator.

AKRON, N. Y.—The village of Akron, N. Y., has voted to install a village electric lighting plant, in connection with the waterworks. A spare engine is available, and generator, switchboard and line are to be installed. Mr. C. W. Ricker, of Buffalo, is consulting engineer.

THE PAN-AMERICAN EXPOSITION.—On January 5 the officers of the Pan-American Exposition Company, with a committee of citizens, accompanied by Senator T. C. Platt, Representative S. Alexander and Justice Hooker, of New York, called upon President McKinley, and received a positive assurance of the assistance and co-operation of the Executive in the work of preparing the exposition.

AN ELECTRIC RAILWAY FROM ELMIRA TO CORNING.—Eastern capital is pledged for the building of an electric railway from Elmira to Corning, Mr. H. B. Rhymer, of Elmira, and Egbert Shoemaker, of Corning, being at the head of the project. Another line is building from Elmira to Watkins, on Seneca Lake. The plan is to use the tracks of existing lines as far as possible, thus taking in way towns and forming a network of roads.

THE M'KINNON DASH COMPANY, makers of buggy tops, etc., is installing an electric power plant to be operated by Niagara Falls power, to consist of one 100-hp, three-phase, 2200-volt Westinghouse induction motor, driving one 40-kw 125-volt direct-current generator to supply lights, power for four small motors and one Chicago arc-welding machine. The induction motor also drives one 60-kw, 300-volt, 60-cycle, alternating-current generator to supply six Thomson electric welding machines. The plant will be started on temporary service with a 50-kw motor in a few days, and will be completed early in February.

BUFFALO GENERAL ELECTRIC COMPANY has just contracted with the Electric Storage Battery Company, of Philadelphia, for a storage battery to be used in connection with its new station operated by Niagara Falls power. The battery consists of 150 cells of 51 plates each, and has a capacity of 3000 amperes for one and one-half hours. It will be divided into two sections, and connected across the new three-wire system which is to supply the business section of the city, and which is operated by rotary transformers. In case the supply of power from Niagara is interrupted, the storage battery will feed into the station bus bars through the rotary transformers, and thus keep the entire plant running. Four 20-point end-cell switches are to be installed with the battery. It is expected to have this in operation in May, 1899. The switchboard for the three-wire system is now being set up and service will be begun in about ten days.

Indiana Notes.

EXTENDING TELEPHONE FACILITIES.—The County Commissioners have granted a franchise for an extension of a telephone line from Morgantown, Morgan County, to Mahusville and Martinville.

A NEW ELECTRIC LINE.—The Indiana Electric Company has completed its interurban line between Goshen and Elkhart, and is open for business. The road has been speedily constructed and possesses numerous improved features. Trains run every twenty minutes.

JUDGMENT FOR THE DIFFERENCE.—A contractor agreed to light the town of Sullivan by electricity for $50 a year per light. He held out two months and quit. A new contract was made with another at $63 per light. The Appellate Court affirms a judgment against the former contractor for the difference.

AN ATTEMPT TO FORFEIT FRANCHISE.—A second attempt is being made to declare the Citizens' Gas & Light Company's franchise forfeited at Portland on the alleged ground of having entered into a combination with other companies to increase prices of gas and electric lights. The case was once appealed to the Supreme Court, but failed for want of proper allegations.

A 60-MILE RIGHT OF WAY.—A number of capitalists of Indianapolis, headed by George P. Marott, have petitioned for a right of way in the Michigan road from Indianapolis to Logansport. If this is obtained a right of way will be secured from Logansport to Warsaw, thereby completing an electric line from Indianapolis to Chicago. The company has filed articles of association, and the possibility of the road being built is encouraging.

Chicago Note.

IT IS REPORTED that the Western Telephone Construction Company, of this city, has concluded negotiations for the purchase of a manufacturing plant in Pittsburg. President J. E. Keelyn is reported to have stated that the company will employ between 400 and 500 men in its new factory, which, it is expected, will be in operation within ninety days. He states that he expects to manufacture at least $1,000,000 worth of telephone apparatus in Pittsburg this year. The new plant consists of brass foundries, machine shops and furnaces. Two of the buildings are 250 feet long and 60 feet wide, and three stories in height. Another building is one story high and about 250 feet long by 100 feet wide. The latter, it is stated, will be used as a foundry. Mr. Keelyn states that the Chicago plant will be continued in operation, but that the Pittsburg factory will probably become the main one. He expects to secure greater economies at Pittsburg because of cheaper fuel, iron and steel. It is reported that the Western Telephone Construction Company has just closed a contract for 100 telephones with the Altoona Phœnix Company and another with the Johnstown exchange.

Pacific Coast Notes.

TELEGRAPH AND TELEPHONE CABLE IN SAN FRANCISCO BAY.—A new Government telephone and telegraph cable was recently laid in San Francisco Bay, extending from the Presidio to Lime Point.

THE PASADENA ELECTRIC RAILWAY, it is reported, has passed into the hands of a syndicate composed of C. P. Huntington, I. W. Hellman, H. E. Huntington, Christian de Guigne and A. Borel, of San Francisco. The syndicate now has control of all the street railways of Los Angeles and Pasadena except the traction company's lines, the Temple Street cable road and the Santa Monica electric railroad. Up to eighteen months ago the Pasadena road was owned by Gen. M. H. Sherman, who sold it to a Chicago capitalist.

THE GOLDSTREAM-VICTORIA TRANSMISSION PLANT.—Mr. Wyn Meredith has returned from Victoria, B. C., where he represented the interests of Hasson & Hunt, of San Francisco, on the occasion of the final acceptance of the British Columbia Electric Railway Company's Goldstream-Victoria electric transmission system. The plant was started on its final official run November 17. One thousand horse-power is being transmitted very satisfactorily. Distance of transmission, 12 miles. Canadian General Electric generating apparatus is used exclusively.

WIRELESS TELEGRAPHY.—Mr. R. Leo Van der Naillen, of Van der Naillen's Engineering School, San Francisco, recently conducted some highly interesting experiments in telegraphing through space. He used instruments of the Marconi type, manufactured in part by himself. He will try to establish communication with the Farallone Islands, 28 miles distant, without the use of wires. Telegraphic communication with those islands would be of inestimable value to the city, for the purpose of reporting ships when fogs prevail along shore, and in time of war.

Canadian Notes.

AT PRESCOTT, ONT., the by-law to raise $15,000 for a municipal electric light plant was carried on Jan. 2.

THE TORONTO ELEVATED RAILWAY COMPANY asks incorporation, with power to construct a system of elevated railways in adjoining municipalities.

WRITS OF SUMMONS against the corporation of the city of London, Ont., have been prepared at the instance of the London Street Railway Company in a suit of damages arising out of the recent strike of the railway's employees. The amount claimed is $20,000, and the wording of the claim is "for inciting riots, causing damage to the plaintiffs, and for neglect of duty and for breach of duty." The meeting of the City Council at which the street railway company was denounced on all sides and the prospective strikers upheld is what the suit for damages is especially aimed at.

STREET RAILWAYS IN JAMAICA.—It is not generally known that Canadians are putting something like $1,000,000 into Jamaica in the shape of an electric street railway. The company is formed of Montreal and Halifax, N. S., capitalists. In this connection Hon. Dr. Johnston, a member of the Jamaica Legislative Council, who is visiting here, introduced a bill into the Jamaica Council and obtained for the company the necessary license to enable it to install the plant in Kingston in 1897. An amendment to this bill has now been found necessary, various complications having arisen by reason of the change of power from steam to electricity. A waterfall, about 20 miles from the city of Kingston, will supply the electric power needed.

THE FRAZIL ICE PROBLEM.—A serious problem is now confronting the Lachine Hydraulic Company, of Montreal, whose power works are situated at the Lachine Rapids, and some interesting experiments for solving it are being tested. A potent obstacle suggested by winter conditions of Canadian water power is the frazil, or anchor ice. This, it has been declared, would interfere with the Lachine water power, would collect in the dam above the water wheels and would choke them, and thus destroy the ingress of the water to the wheels more securely than if it were solid material. Frazil does not form in still water, but in swiftly running currents and rapids, and then is forced into the eddies and still water, and becomes the dread obstruction that has defied engineering effort. To meet this difficulty the engineers boomed the river from the outer end of the dam to the river bank, with the idea that the floating solid and anchor ice would strike the boom in a slanting manner and be carried gradually off to the outer edge of the boom into the channel of the rapids.

General News.

NEW INCORPORATIONS.

THE CREED ELECTRIC HEATER COMPANY, Portland, Me., has been formed for the purpose of manufacturing electric heaters. The incorporators are W. K. Lazee, W. D. Flagg, Providence, R. I.; P. T. Creed, Taunton, Mass. Capital stock, $125,000.

THE BERNSTEIN ELECTRIC MANUFACTURING COMPANY, Portland, Me., has been incorporated, with a capital stock of $100,000, for the purpose of manufacturing electrical apparatus. The incorporators are A. W. Putnam, Salem, Mass.; E. S. Gardner, Wollaston, Mass.; C. F. Langley, South Boston, Mass.; J. T. Knapp, Roxbury, Mass., and C. H. Tolman, Portland.

THE HAVANA ELECTRIC RAILWAY COMPANY has been incorporated at Trenton, N. J., with a capital stock of $7,000,000. Its objects are to manufacture and sell electric power and to sell gas in the West Indies, and to operate railways, cables, telegraph and telephone lines, light towns, cities, and buildings, and to do many other things. It is understood that the company is formed for the specific purpose of acquiring the street railways in the city of Havana. The incorporators are W. P. S. Melvin, of East Orange, N. J.; G. K. B. Wade and Herbert A. Howell, New York city.

THE TELEGRAPH AND TELEPHONE.

SPRINGDALE, ARK.—The Springdale Telephone Company has been incorporated with a capital stock of $25,000.

PIERCE CITY, MO.—The North Arkansas Telephone Company has been incorporated at this place with Millard Berry, president; James W. DuPree, vice-president; J. P. Deaver, secretary and treasurer.

ANNA, ILL.—The City Council, at its last general meeting, appointed a committee to secure information, specifications and plans for the erection of an electric light plant. It is probable that waterworks will be included.

ROCHESTER, N. Y.—The Empire State Telephone Company is perfecting arrangements to build a metallic circuit from Atlanta through Naples, Middlesex and Rushville, to Geneva, connecting there with all points on its lines and also the lines of the Long-Distance Telephone Company.

JOPLIN, ILL.—A joint committee of the Joplin Club and City Council, appointed to look into the matter of building a municipal electric light plant, has agreed to recommend the erection of such a plant to cost $30,000, and that bonds be issued to pay for the same. The plant will have a capacity of 200 arc light and 5000 incandescents.

CAMDEN, N. J.—An indictment has been returned by the Camden County Grand Jury against the Western Union Telegraph Company for transmitting messages giving policy drawings. Similar indictments were found by the Hudson County Court in Jersey City against the same company, as noted among the New York notes in this issue.

POTTSTOWN, PA.—Telephone subscribers in this place now have the benefit of reduced rates, brought about by the extension of the Keystone Telephone Company's lines to this section. Up to this time the Delaware & Atlantic Company has had control of all the business, and 'phone rates were $50 for business places and $40 for residences. Hereafter they will be $30 and $20 per year respectively. The Keystone lines extend to Norristown through a number of Montgomery county boroughs.

BOSTON, MASS.—The Bell Telephone instrument statement for the month ended December 20, 1898, shows gross output of 41,037 and net output 27,771, as compared with a net output of 17,575 during the previous year. During the year ended the same date the gross output was 354,559, and the net output 205,725, as compared with the net output of 148,404 in 1897. The total number of instruments outstanding on December 20 was 1,125,246, against 922,253 at the end of the previous year. The total number of instruments outstanding five years ago was 582,506.

TOPEKA, KAN.—A bill has been introduced into the Legislature to reduce the telegraph tolls in Kansas at least 40 per cent. from the present rates. It provides that the charge for a ten-word day message shall not exceed 15 cents between points within the State, and one-sixth of 1 cent per word for press messages received between 6 P. M. and 6 A. M. Telegraph companies are classed among the corporations which are placed under the control of the new Court of Visitation, which is charged with the duty of bringing action against such companies in case of failure to comply with the law.

DES MOINES, IA.—The city has begun action in the District Court to oust the Iowa or old telephone company from the streets of Des Moines. The city claims the company's franchise expired in 1896 and has not been renewed; that the city ordered it off the streets several months ago and that it has not complied with that order, and that it has no rights in the city. The court is asked to order the company's poles and wires out of the streets entirely, and in case of failure, to give the city the right to chop down the poles. The company claims vested rights and will contest the case to protect its investment of about $100,000 here.

BALTIMORE, MD.—The plan for the reorganization of the Home Telephone Company in the interest of the shareholders has been announced by the shareholders' committee. If the arrangement is carried out the shareholders of the company will have an opportunity of realizing the value of their shares. Judge Wickes, of the Circuit Court, has signed a decree ordering a sale of the property of the Home Telephone Company and of the Home Telephone & Home Telegraph Company, Messrs. Walter B. Brooks and John C. Distler, Jr., the receivers, being appointed to make the sale, their bond being fixed at $200,000. The property will probably be bid in by the stockholders.

TOPEKA, KAN.—Representative Merrill, of Sedgwick, has introduced a bill in the House providing for county ownership of telephones. It provides that upon a petition signed by 5 per cent. of the voters of a county the question "Shall the county own its telephone system?" shall be submitted to a vote of the people at the general election. If the proposition carries, then the county shall build a system and supply every farmhouse with a 'phone. The expense of building and operating the plant is to be borne by direct taxation, and the county is given authority to spread out the original cost of construction over ten years, one-tenth to be paid each year. The same bill also provides for intercounty ownership.

BOSTON, MASS.—It is stated that papers have recently been executed calling for the transfer of a large stock interest in the Michigan Telephone Company, which will place the management of that concern under the control of the Erie Telegraph & Telephone Company. The Michigan Telephone Company operates exclusively in the State of Michigan, and is a lessee of the American Bell Telephone Company. It has 19,000 subscribers and 10,000 miles of long-distance lines. Its capital stock is $2,500,000. The new arrangement, it is stated, places under the Erie Telegraph & Telephone Company's management the largest number of telephone subscribers in the United States, namely, 50,000. This company controls 30,000 miles of toll lines in the States of North Dakota, Minnesota, Michigan, Arkansas and Texas and Cleveland, Ohio.

ELECTRIC LIGHT AND POWER.

THE CITY OF VEEDERSBURG, IND., is erecting an electric plant. The Ball Engine Company, Erie, Pa., will furnish the engine.

TRENTON, N. J.—The Electric Company of America filed articles of incorporation on January 5, with a capital stock of $25,000,000. According to the incorporation papers, the object of the company is to manufacture, produce, purchase, own, use and sell public and private users, coke, coal, gas, oil, electricity, light, heat, steam and compressed-air power, water, etc., and to acquire, construct, lease and operate plants in connection therewith. The incorporators of the new company are James E. Hayes, a Camden lawyer; Elmer Smalling and Arthur Phillips, of Philadelphia. It is stated that these gentlemen, however, merely represent the real financial interests back of the company. It is thought that Messrs. Whitney, Widener and Elkins are interested in the new concern. It is surmised by some that the real purpose of the company is to bring together the stock ownership of numerous electrical concerns, and that it will be used as the merger company for the consolidation of all the New York city electric companies, taking in the New York Gas, Electric Light, Heat & Power Company among the others. A great many explanations are being put forward in various quarters as to the real purpose and the real promoters of the newly organized company, and all seem to agree that the financiers named are at the back of the new enterprise.

TRENTON, N. J.—The United Lighting & Heating Company has been incorporated here with a capital stock of $12,000,000. It is understood that the Whitney syndicate is interested in this enterprise, as well as in the Electric Company of America, which was incorporated on January 5. The object of the new company is to manufacture, sell and lease to public and private consumers gas and oil machines and appliances of all kinds for the production of light, heat and power. The incorporators are Edwin Hand, Jr., of Philadelphia; F. H. MacMorris, Philadelphia, and John M. Devlin, Gloucester City, N. J. It is stated that the same syndicate that is behind the new concern and the Electric Company is back of the Gas Trust, which has been in existence for some time, and that the purpose is to operate the three systems of furnishing light, namely, electricity, oil and gas. It is stated that the Electric Company of America will be simply a merger concern designed to hold the control of stocks and bonds, and it may not be an operating company at all. The function of the United Lighting & Heating Company will be to take in other forms of lighting and heating than electricity and gas, and will bring together all of the interests of this kind that have been acquired by the United Improvement Company, of Philadelphia. In this connection a Philadelphia dispatch states that the United Lighting & Heating Company will be in the hands of the Widener-Elkins-Dolan syndicate, and that its main object will be to obtain street lighting franchises in cities and towns all over the country. The company will use an incandescent gas light and a system of lamps lighted with oil under pressure, recently invented.

THE ELECTRIC RAILWAY.

ROCHESTER, N. Y.—The State Street barns of the Rochester Railway Company were destroyed by fire on the night of January 1, the damage amounting to $50,000. Twenty-one cars were destroyed.

NEWPORT NEWS, VA.—It is stated that the Newport News & Old Point Railway & Electric Company will build a new power house in this city for the operation of its local lines. The company will lay about 4 miles of track in Newport News.

ALBANY, N. Y.—The New York & Westchester Electric Railroad Company has certified to the Secretary of State a proposed extension of its lines in the village of Pelham Manor, and also along Pelhamdale Avenue and the Shore Road to the New Rochelle boundary line; also along the Boston Turnpike from Pelhamdale Avenue to the New Rochelle boundary line.

ALBANY, N. Y.—The State Railroad Commissioners' report for the year 1898 shows that the total number of passengers carried by the elevated railroads in New York city was 227,776,552, a decrease of 1,019,129 as compared with 1897. The number carried in the boroughs of Manhattan and the Bronx was 183,360,846, an increase of 395,995 over 1897. The decrease in the number carried in the Borough of Brooklyn was 1,465,124. The street surface railroads of the entire city carried 456,963,753 passengers, including transfers, an increase over 1897 of 57,538,010. The number carried in the Borough of Brooklyn was 217,410,612, including transfers, which is an increase of 17,224,793. The street surface railroads of the State carried 849,310,670 passengers, an increase over 1897 of 90,541,093.

MOUNT VERNON, N. Y.—The Common Council has revoked the franchise recently granted to the New York, Westchester & Connecticut Traction Company, over which considerable trouble has arisen. Charges have been made that the granting of the franchise was irregular in that the city clerk suppressed the application of the Westchester Electric Company for a like franchise. The Board of Trade took the matter up and made an investigation with

the result that the city clerk will be required to answer the charge of suppressing a public document. The Board of Trade, or at least the active members of it, are urging the aldermen to favor the Union Railway Company, because it is already operating lines in Mount Vernon, Yonkers, New Rochelle, Pelham and as far as One Hundred and Twenty-ninth Street, New York. They say that if a rival company is permitted to build a line in the city it cannot give a complete service, but will have to transfer to the Union lines, which will cost the passenger another 5 cents, whereas the Union company agrees to carry passengers from any point of its system above the Harlem River to another for a single fare of 5 cents. Mayor Fiske and the friends of the traction company say they are not in favor of a single company having a monopoly of the city, and that their actions in blocking the Union company have been for the public good.

Legal Note.

THE SERIES-PARALLEL CONTROLLER CASE.—On December 23, 1898, the United States Circuit Court of Appeals for the Second Circuit, held in New York, denied the petition for a rehearing in the case of the Electric Car Company of America and the Thomson-Houston Electric Company, appellees, v. the Nassau Electric Railroad Company, appellant. On December 20 the same court affirmed the order of the Circuit Court of the United States for the Southern District of New York in the same case, granting a preliminary injunction against the Nassau Electric Railroad Company as to the twentieth, twenty-first, twenty-second, twenty-seventh, twenty-eight, twenty-ninth and thirty-first claims of the United States letters-patent granted to George Herbert Condict, No. 393,329, for improvements in switches for electric motors.

Personal Note.

MR. W. B. UPTON, of Washington, D. C., has resigned the position as principal assistant engineer of the Capital Traction Company, of that city, the work of changing from cable to the open-conduit electric system having been completed. Mr. Upton will resume office practice in Washington, making a specialty of open-conduit systems, power stations and general engineering. An illustrated description of the open-conduit system of the Capital Traction Company was published in The Electrical World of December 31 1898.

Trade and Industrial Notes.

THE FLINT & PERE MARQUETTE RAILWAY has recently purchased a 165-hp engine for electrical purposes, from the Ball Engine Company, Erie, Pa.

CHANGE OF NAME.—The Michigan Phonograph & Novelty Company, 101 Woodward Avenue, Detroit, Mich., has changed its name to the American Phonograph Company.

THE BALL ENGINE COMPANY, Erie, Pa., will furnish the engine to be used in the electric light plant being erected by the Seckner Contracting Company at Churubusco, Ind.

THE AMERICAN ENGINE COMPANY, of Bound Brook, N. J., builder of the American Ball engines and electrical machinery, has opened an office in New York city, in the White Building, 95 Liberty Street.

WHITNEY ELECTRICAL INSTRUMENTS.—The Electric Appliance Company, Chicago, has ready for distribution a complete catalogue of Whitney electrical instruments. A copy of this catalogue should be in the hands of every buyer of testing instruments.

THE C & C ELECTRIC COMPANY has moved its Philadelphia office from 633 Arch Street to 45 North Seventh Street. The new offices are much larger and more attractive, and Mr. William Myers will be very glad to welcome there the friends of the C & C Electric Company.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, in its Circular No. 47 gives a good description of and illustrates the accumulators in the sub-stations of the South Side Elevated Railroad Company, Chicago, Ill. Various instructive details are given, and diagrams show the plan of the feeder lines on the road.

THE LEAVITT MACHINE COMPANY, Orange, Mass., has issued a pamphlet on the Morse & Dexter valve-reseating specialties, showing the latest machines and attachments for reseating valves and their discs, ranging from one-fourth to 12 inches in diameter. Views are given of some of the American warships on which these machines are used.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY in its Circular No. 61 describes and illustrates its direct-current engine-type generators. Perspective views of the various parts of this machine, together with the outline drawings of the same, are given, besides a complete table of dimensions for use in connection with the drawings.

MECHANICAL DRAFT.—A second illustrated edition of the lecture on "Mechanical Draft Steam Boilers," delivered at Cornell University by Walter B. Snow, of the engineering staff of of the B. F. Sturtevant Company, Boston, Mass., has just been issued to meet the demand for information on this important subject. Copies may be obtained upon application to the Sturtevant company.

A UNIQUE GENERATING SET.—In its recently issued Bulletin G the B. F. Sturtevant Company, of Boston, Mass., illustrates and describes a unique generating set, in which both the engine and the generator are entirely enclosed, although perfectly accessible through suitable doors. Such a device is of manifest utility wherever the atmosphere is laden with dust. A copy of this bulletin, which contains other information of interest, will be mailed on application.

THE A. H. BARBOUR MANUFACTURING COMPANY, of Chicago, Ill., has been awarded the contract to equip the Westcott Hotel, in Richmond, Ind., with a complete gas-engine plant for electric light and power purposes. It will consist of two 50-hp Miller gas engines, which will furnish power for driving dynamos. The dynamos will furnish current for the lighting, elevator motors, laundry and refrigerating machines. It is claimed that this will be one of the finest gas-engine plants in this country.

CROSS OIL FILTERS AND PURIFIERS are used in many of the largest electric light and power stations throughout the country. A notable application of their use is in the plant of the Capital Traction Company, Washington, D. C., which was fully illustrated in The Electrical World of December 31, 1898. Here two 80-gallon Cross filters are used in connection with the oil-circulating system of the station. The Burt Manufacturing Company, Akron, Ohio, manufactures these filters.

COMMERCIAL DYNAMOS IN JAPAN.—The Commercial Electric Company, Indianapolis, Ind., has recently installed a complete lighting and power plant for the Omi Mashi-Boseki Kwaisha, Kioto, Japan, which is a large flax-spinning mill. All the machinery and supplies furnished were of American manufacture, and installed through the Commercial company's agent, Paul G. Fiedler, Yokohama. This is the fourth plant installed for the Commercial company in Japan by Mr. Fiedler within the last few months.

MR. H. W. WISWELL, who for the past year has been associated with the New York & Ohio Company, Warren, Ohio, as the manager of its transformer department, has resigned his position, his contract with that company having expired. Mr. Wiswell has accepted a position of like nature with the Warren Electric & Specialty Company, of the same place. The Warren company will place upon the market its new "Peerless" transformer, which it claims will be a distinct improvement upon anything now available. It expects to be able to make deliveries about April 1 next.

MESSRS. CHARLES H. BESLY & CO., 10 and 12 North Canal Street, Chicago, Ill., manufacturers and dealers in machinists' hardware, report a very successful business for the year 1898, just closed, a decided improvement being noted in the demand for the specialties of their own manufacture. Among foreign orders may be noted shipments to England, Russia, France, India, Brazil, the Argentines, Uruguay, Chili, Peru, Bolivia, as well as large shipments to the jobbers and manufacturers in this country. Their factory at Beloit, Wis., is being run full time, and they regard the outlook for the future as very bright.

THE ROEBLING CONSTRUCTION COMPANY.—A Trenton, N. J., dispatch states that the John A. Roebling's Sons Company proposes to extend a branch of its business, and has, with this object in view, organized a new company to be called the Roebling Construction Company. The object of the new concern will be to manufacture iron for fireproof construction of buildings, and its business will be extended to Europe and the Orient. The capital stock is to be $250,000. The material will be manufactured at the Roebling's company's mills in Trenton. The gentlemen interested in the new company, it is stated, are associated with the John A. Roebling's Sons Company.

"THE TWENTIETH-CENTURY MOVEMENT" is the title of an eight-page pamphlet just issued by the American Electric Vehicle Company, 1545 Michigan Avenue, Chicago. In addition to pointing out the principal features of this company's vehicles, illustrations of a runabout buggy, an American brougham and a delivery wagon are shown. The storage batteries used are claimed to be powerful, light and compact, and will run the vehicles 35 miles on one charge. It is also stated that the cost of running is 1 cent a mile. The vehicles have a single-motor equipment. The motors are dust and waterproof, and are so compact and so placed as not to mar the appearance of the carriages. The speeds of the vehicles may be regulated to meet the demand of the road, from 2 to 12 or 15 miles an hour.

MESSRS. J. HOLT GATES & CO., Marquette Building, Chicago, report the following recent sales: Armour Glue Works, Chicago, one 225-kw 500-volt generator, two 150-kw 500-volt generators, seven 50-hp motors, two 100-hp motors, two 150-hp motors, one 30-hp motor and two 25-hp motors, made by the Card Electric Company, Mansfield, Ohio; Deering Harvester Company, Chicago, seven 500-light transformers, five 400-light and three 200-light transformers; Elkhart Lake Electric Light Company, Elkhart Lake, Wis., two 10-hp single-phase motors and transformers and direct current dynamos, connected to large storage batteries for electric launches; Armour Glue Works, Chicago, one $3000 switchboard; Pierce & Robinson, Chicago, one $700 switchboard; residence of P. D. Armour, Jr., Chicago, one 300-light electric light plant with Nash gas engine direct connected.

THE TWENTIETH ANNUAL NUMBER OF THE "TRADESMAN," which is published at Chattanooga, Tenn., contains a vast amount of information regarding the manufacturing industries in the South. Among its contents are an article on "Mica Mining in the Southern Cities," by Prof. F. B. Venable, in charge of the chemical laboratory, University of North Carolina; and an article entitled "Progress of Electrical Development," written by A. S. Heywood, of Atlanta. This article relates principally to electrical development in the South during the past year. This extraordinary number of the "Tradesman" will no doubt be very valuable to those having trade relations with the South. Not many people in the North realize the extent of the industrial activity in the Southern States, and the light thrown upon this subject by the "Tradesman" will no doubt be a revelation.

THE SPRAGUE ELECTRIC COMPANY, New York, has issued a very handsome and complete catalogue on the Lundell power motor, exemplifying a great variety of applications of this machine. Half-tone illustrations represent the two-pole Lundell motor in section, two-pole spherical motor, six-pole slow-speed motor, six-pole slow-speed motor generators, motor controllers, brushes and brush holders, etc., together with views of the elementary parts of these machines. Tables and diagrams are given showing the dimensions of the various types of motors, and at the back part of the pamphlet are illustrations of actual applications of Lundell motors to a variety of machines and uses, such as linotypes, belt-driving of shafting, direct connection to printing presses, geared to paper cutters, belted to die presses, hydraulic pumps, etc., etc. The pamphlet contains seventy-two pages, and is gotten up very artistically.

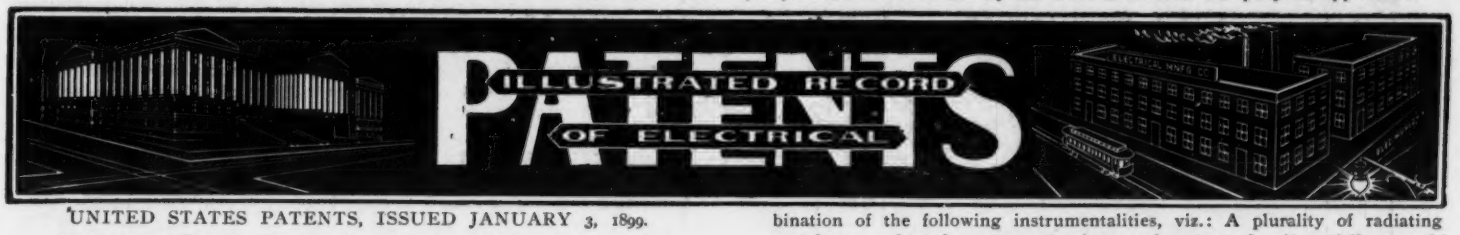
SYNDICATE TO BUILD COMPRESSED-AIR MOTORS.—A dispatch from Providence, R. I., states that the Leiter syndicate has secured control of the Rhode Island Locomotive Works and will operate them as one of the plants of the International Air Power Company. This company has also absorbed the Wheelock Engine Company, of Worcester, and purchased all the Hoadley-Knight compressed air patents of Europe. The capital stock of the company, which was organized in New Jersey, is $7,000,000. The American rights of the Hoadley-Knight compressed-air system are controlled by the American Power Company, of New York, and the Leiter syndicate will manufacture its appliances. Mr. Joseph H. Hoadley, who represents Mr. Joseph Leiter, states that the Leiter syndicate will make many thousand trucks for New York and Brooklyn and London. Among the stockholders of the International Air Power Company are named the Cramps, of Philadelphia, Mr. Leiter, of Chicago, and the Elkins-Widener-Dolan syndicate, of Philadelphia.

MR. C. v. OSSOWSKI, engineer and patent agent, Potsdamerstrasse 3, Berlin, Germany, has issued a pamphlet for circulation among patent agents giving information as to the rules of practice relating to patents, trade-marks, and designs in Russia. Some of the provisions of the Russian patent law may seem rather odd to Americans. For instance, if identical applications for a patent be filed on one and the same day by different applicants, the applicants are first requested by the Department of Trade and Manufactures to apply for a joint patent. If this request leads to no result, it is determined by the court which applicant has the prior right to the patent. If, however, this should still give no positive result, then both applications are absolutely refused, and neither applicant receives the patent, the invention then becoming public property. In order that a patent granted in Russia may retain its full validity and legal power, annually increasing taxes must be paid thereon. Mr. v. Ossowski has had experience in the obtaining of Russian patents and registration of trade-marks and designs, and is prepared to procure such.

THE WARREN ELECTRIC MANUFACTURING COMPANY, of Sandusky, Ohio, has appointed Messrs. J. Holt Gates & Co., 1426 and 1427 Marquette Building, Chicago, general agents for its apparatus in the territory around Chicago. The Warren Company has recently placed, through J. Holt Gates & Co., a 15,000-light, alternating-current plant for the new power and light plant of Armour & Co. at their extensive works at the Union Stock Yards, Chicago. This plant will comprise one machine, of 7000 16-cp light capacity, at 1100 volts and 7200 alternations, and two 3600 lighters, 1100 volts and 7200 alternations. These alternators, of the inductor type, will be operated by rope drive from Corliss engines of 2000 horse-power and 1100 horse-power, to which will also be attached Walker direct-connected power generators. It is stated that the Warren alternators were selected on account of their close regulation, high efficiency, low temperature and ability to stand "grief." The Warren Company is now prepared, in its new factory, to build 10,000-light machines, both single and two-phase. It has sixty-odd machines on order at the present time. Its new plant is modern and up to date.

AMERICAN TRADE INDEX.—The National Association of Manufacturers of the United States of America has just issued a descriptive and classified directory of manufacturers engaged in export trade, which has been published for foreign circulation. This directory represents one feature of the practical work that is being done by the National Association of Manufacturers in the extension of the foreign trade of the country. The index embraces the names and addresses of manufacturers, the lines of goods they make which are adapted to exporting, the foreign agents of the manufacturers, the registered cable addresses and the telegraphic cipher codes that are in use. The arrangement of the contents is such that any information on the subject covered can be readily obtained. The first edition consists of 5000 copies in the English language, which is being distributed free of cost to the principal merchants in the English-speaking countries. The preparation of a similar edition in Spanish is already in progress, and this will be distributed in Cuba, Porto Rico, the Philippines and those countries where the Spanish language is most in use. Other editions in different languages will follow as rapidly as they can be prepared. The index includes the names of well-known concerns engaged in electrical and kindred industries.

TRANSFORMER DESIGN AND OPERATION.—Under this title the General Electric Company has issued in pamphlet form two important papers on the subject of electrical transformers. One is written from the standpoint of the central station manager by Mr. W. F. White, general manager of the Omaha (Neb.) Electric Light, Heat & Power Company; the other, by Professor Winder Elwell Goldsborough, deals intimately with the question of transformer economy. The first paper, which was read before the American Institute of Electrical Engineers, is the record of long personal experience with the operation of transformers under actual commercial conditions, showing the relation of the many losses incident to the use of many small transformers, to the earning capacity of the plant, and the tangible economies realized as the result of the substitution of a few high-efficiency transformers of large capacity. Mr. White gives examples of these economies reduced to dollars and cents. In his station a saving of $6000 per annum in the cost of coal alone was realized as the result of the practical application of lessons drawn from his extended observation and experience. Professor Goldsborough's paper was read before the National Electric Light Association, and treats of the inherent economy of transformers of various design and construction. It contains many able arguments in favor of the use of high-grade transformers, and emphasizes the necessity of frequent tests as the only means of detecting leaks, losses and the general depreciation of transformers. To these papers the General Electric Company has added several maps, showing graphically the significance of the substitution of a few large transformers for numerous small ones. A copy of the pamphlet will be sent free by the General Electric Company on application.



UNITED STATES PATENTS, ISSUED JANUARY 3, 1899.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

11,706. ELECTRIC BUOY. E. W. G. C. Hoffmann, of Charlottenburg, Germany. App. filed Dec. 8, 1898. The combination in a submersible marine appliance, with a water-ballast chamber, of a pump associated therewith, a reversible electric motor actuating said pump and adapted to effect the entrance of water to or the expulsion of water from said chamber, according to the direction of rotation of said motor, and means controllable from without the appliance for effecting the actuation of the motor and pump, substantially as described.

616,879. ELECTRO-MECHANICAL GONG. C. E. Beach, of Binghamton, N. Y. App. filed May 14, 1896. A magnetically controlled releasing device. a revoluble part provided with projections capable of engaging with a portion of said releasing device, a gear moving with said revoluble part, a pinion engaging with said gear and with an internal gear and a striking mechanism operated by the movement of said pinion around the axle of the gear for the purpose described.

616,895. DOWEL FOR CONDUIT PIPES. S. Carroll, of St. Louis, Mo. App. filed October 8, 1898. The herein described dowel, for use in connection with refractory conduits, the same comprising a body portion from which is struck or bent up one or more laterally pojecting fins or bus, substantially as described.

616,953. TELEPHONE RECEIVER. J. J. Mulconroy, of Philadelphia, Pa. App. filed May 7, 1898. In combination with a telephone receiver, a cushion formed of yielding material shaped as an annular body of approximately semi-cylindric transverse section, its outer edge tightly embracing the exterior of the receiver, its inner edge resting freely or unsecured against the end face of the receiver, and its intermediate portion elevated from the surface of the receiver to form an air chamber, substantially as described.

616,956. ELECTRO-MAGNETIC BRAKE. F. C. Newell, of Chicago, Ill. App. filed Feb. 5, 1898. In an electric car, the combination with the two electric motors for driving it of an electric circuit, independent of the motor circuit, connecting the field of each motor in series with the armature of the other, said independent circuit being normally open and having terminals, circuit-closers operative at will to engage said terminals to close and independent circuit, and thereby convert said motors into generators operated by the inertia of the car in motion, and an electromagnet track-brake device in said independent circuit supported with its poles extending to engage a track-rail forming its armature.

616,972. ELECTRIC CONDUCTOR SUPPORT. J. M. Anderson, of Boston, Mass. App. filed Feb. 8, 1898. In an electric conductor support, the combination of the following instrumentalities, viz.: A plurality of radiating metal arms adapted to carry crossing conductors and substantially trough-shaped auxiliary sheet-metal terminals detachably secured to the outer ends of said arms and extended underneath said arms and conductors, substantially as described.

616,978. STORAGE BATTERY. F. W. Schneider, of Triberg, Germany. App. filed Dec. 3, 1896. In a secondary battery, the combination with a supporting frame consisting of a series of insulating troughs, arranged one above the other and having perforated side walls of trough-shaped current conductors inserted in said trough and having projections on their inner surface, and of active material filled in said current conductors, substantially as described.

616,979. MEANS FOR COOLING DYNAMO-ELECTRIC MACHINES. G. W. von Siemens and A. W. H. Rotth, of Berlin, Germany. App. filed Oct. 22, 1898. In a dynamo-electric machine, the combination with the windings thereof, of corrugated sheet metal disposed in contact with said windings, whereby the radiating surface thereof is augmented, substantially as described.

616,983. TRAVELING TEST APPARATUS. E. Speiman, Jr., of Washington, D. C. App. filed Dec. 6, 1897. The combination with a way of a traveling test apparatus mounted on the way, comprising a carrier, and a keyboard supporting the test devices, substantially as described.

617,003. TUBULAR ELECTRODE FOR STORAGE BATTERIES. T. A. Willard, of Cleveland, Ohio. App. filed Jan. 26, 1897. An electrode circular in cross-section, hollow through the centre and having a series of annular ledges from top to bottom, uniform in cross-section from edge to base, and having uniform spaces between them, and curved outward and upward from their base, substantially as described.

617,004. STORAGE-BATTERY ELECTRODE. T. A. Willard, of Cleveland, Ohio. App. filed Jan. 26, 1897. An electrode for batteries having a succession of shelves, one above the other, upon its outside, and a hollow body closed across its ends to exclude liquid, and a stiffening core of different material in said body within said ends, substantially as described.

617,024. ELECTROLYTIC REDUCING AND AMALGAMATING SLUICE. J. H. Jory, of San Francisco, Cal. App. filed May 27, 1897. A reducing and amalgamating sluice having a series of closely arranged metallic plates, with passages therebetween, suitable electrical connections for alternately charging the plates positively and negatively, and a readily fusible metallic covering or coating surrounding the permanent negatively charged plates, substantially as described.

617,062. INSULATING ARM. J. D. Taliaferro, of London, Tenn. App. filed June 18, 1898. An insulating arm, comprising a metal supporting rod or

core, annular insulators strung upon said rod and having wooden bushings and spacing sleeves of insulating material covering the rod between said annular insulators.

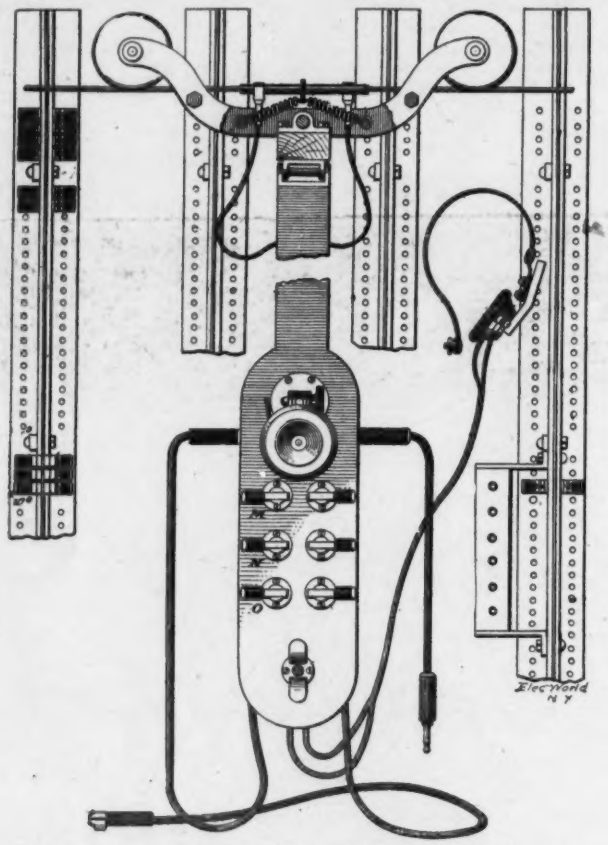
617,064. NAIL, HOOK, OR STAPLE. H. Traun, of Hamburg, Germany. App. filed Dec. 3, 1897. As articles of manufacture, a nail, hook, staple, or the like, of the class specified and made of vulcanite, substantially as described.

617,067. HELIX FOR ELECTRICAL APPARATUS. J. T. Williams, of New York, N. Y. App. filed April 3, 1895. The combination of a coil or helix and a second open-circuited coil or helix wound in inductive relation thereto, for the purpose of suppressing the impedance or self-induction therein, substantially as described.

617,111. FIRE-DAMP DETECTOR. G. A. Lyncker, of Munich, Germany. App. filed March 11, 1897. A fire-damp detector, in which are combined an air-tight chamber, an electric alarm and electric battery therein, a dome in said chamber with a central neck open at the upper end, a movable plug or piston fitted in said neck and provided with a metallic head, forming a circuit-closer, electrodes projecting laterally into the neck of the dome at a point normally above said metallic head of the piston and electric connections between the electrodes, the alarm and the battery, the whole being adapted to operate substantially as described.

617,114. ELECTRIC MOTOR. C. R. Meston, of St. Louis, Mo. App. filed July 9, 1898. The combination with a motor, comprising field magnets and an armature, of an insulated frame-plate for supporting said parts, and a bottom plate for enclosing said parts, said bottom plate being secured to the insulated frame plate, substantially as described.

617,121. APPARATUS FOR ELECTRIC-CURRENT SUPPLY, etc. E. J. Preston and A. B. Gill, of London, Eng. App. filed Dec. 29, 1897. The combination with a dynamo, two storage batteries, a charging circuit and a service circuit, and connections between said circuits and said batteries, of a reversible contact-lever, which is automatically reversed and moved into contact by the reversal of the rotation of the dynamo, and which is provided with an actuating arm, and a rocking switch lever for alternating the



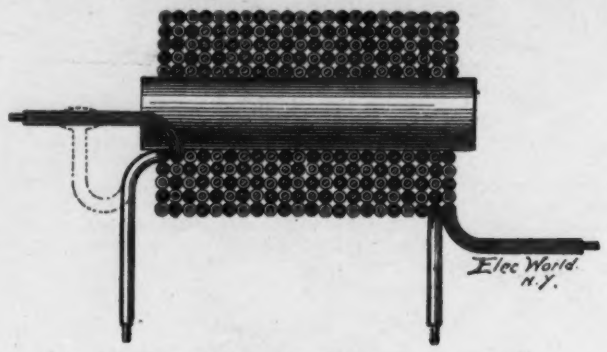
No. 616,983.—Traveling Test Apparatus.

connections between the storage batteries and the charging and service circuits, and which is automatically shifted by said actuating arm as the contact lever is moved into contact.

617,128. ELECTRIC ELEVATOR. A. B. See, Nils O. Lindstrom and D. A. Mason, of New York, N. Y. App. filed April 26, 1898. An electric elevator, comprising a main propelling motor, an auxiliary motor for making or reversing the motor circuits, and a dashpot operated by the auxiliary motor shaft for slowing the movement of said device near the ends of its traverse in either direction.

617,139. ELECTRIC BLOCK SYSTEM FOR RAILWAYS. H. Baluss, Jr., of Wayne, Michigan. App. filed Dec. 31, 1897. A system of trolley wires for an electric railway, comprising a main trolley wire turned out of line at intervals and run parallel with the line at one side thereof, two detached sections of wire in the main line filling the gap made by turning the main wire aside, a loop connected at each end with the main wire and mounted over a turnout, and two branches, one connected to each detached section and mounted over the turnout parallel with the loop from the main wire, insulated from it and from each other.

617,145. TELEPHONE EXCHANGE SWITCH AND SIGNAL APPARATUS. W. W. Dean, of Boston, Mass. App. filed March 19, 1898. The combination in the double-conductor switch plug and cord connection of a telephone switchboard, of two terminal loop-conductor sections, each extending between the two switch contacts of their respective plugs, and a source of current through which both are closed; an intermediate conductor section conductively united to one, and inductively united to the other of said loop sections, and constituting with them a continuous circuit connection for voice currents between the said plugs, a condenser interposed in the circuit of said intermediate section and impedance coil relay in the conductively united terminal section; and an induction-coil, relay having its windings in the other terminal section and the intermediate section respect-



No. 617,067.—Helix for Electrical Apparatus.

ively and forming the said inductive union between them, said relays constituting signal controlling devices.

617,165. SYSTEM OF ELECTRICAL DISTRIBUTION. S. Kirlin, of Watertown, S. Dak. App. filed August 18, 1898. A system of electrical distribution consisting of a primary circuit, a secondary circuit, two or more transformers, common to both circuits, and a responsive device in the primary circuit, that will automatically control the number of transformers included in the said cicuits, to correspond with the increase and decrease demands of the said secondary circuit, substantially as described.

617,187. MEANS FOR GENERATING ELECTRICITY FROM MACHINERY OF LOCOMOTIVES. App. filed Oct. 10, 1898. The combination with the reverse-lever of a locomotive, or its connecting parts to and including the link shaft of a switch operated thereby, and means for causing said switch to effect a contact in one or the other of its two positions, depending upon the direction in which said reverse-lever is thrown, regardless of the amount of throw given said reverse lever, substantially as described.

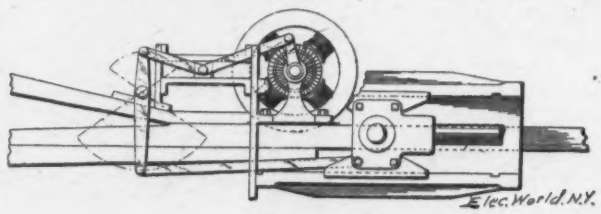
617,192. ELECTRIC PROPULSION OF VEHICLES. F. W. Schneider, of Triberg, Germany. App. filed Dec. 10, 1897. An electrically propelled vehicle, provided with a motor, two storage batteries of different capacity and a switch, whereby both batteries, or only one of them, may be connected with the motor.

617,193. ELECTRIC SWITCH. O. H. Schuck, of Philadelphia, Pa. App. filed July 2, 1898. For use in connection with an electric alarm circuit, a switch comprising a swinging arm, a contact brush, a spring for normally holding the switch arm in connection with the brush, a lug at the free end of said switch arm, a spring-pressed sliding plate, and a lug on said plate, with which the lug on the arm is designed to engage to hold the switch arm in its open position.

617,216. PILOT-WIRE ROD FOR ELECTRICAL CONDUITS. James Arnot, of Kearny, N. J. App. filed May 24, 1898. The improved pilot-wire rod comprising sections having shafts and radial runners disposed at the ends of said shafts and holding said shafts from frictional contact with the conduit, said parts being combined, substantially as described.

617,275. QUICK-BREAK ELECTRIC SWITCH. W. F. Bossert and G. L. Holton, of Utica, N. Y. App. filed June 9, 1898. In an electric switch, the combination with electric contacts forming terminals of the circuit in which the switch is placed, of a pair of independent switch-blades pivoted at one end to one of the contacts, a coupling having grooves in its inner face to receive the other or free ends of the pair of switch-blades, means connecting the blades and coupling, and actuating means for operating the switch.

617,287. CIRCUIT-CLOSER. J. D. Garlock, of Palmyra, N. Y. App. filed April 22, 1898. In a device of the character described, the combination with an indicator case having an annular seat, of a flaring face-ring mounted upon said seat to be turned in either direction, a face plate secured to said



No. 617,187.—Means for Generating Electricity from Machinery of Locomotives.

ring parallel with the glass face of the indicator, a stud held rigidly in said face plate and terminating within the case in a curved end, a wire connected with the outer end of said stud, and a second stud carried by the face plate and adjustable to and from the other stud with its inner end within the case curved toward the curved end of the other stud, and a wire connected to the outer end of the said stud, and a pointer adapted to vibrate between the curved ends of said studs.